UNION OF SOUTH AFRICA

DEPARTMENT OF COMMERCE AND INDUSTRIES

DIVISION OF FISHERIES

INVESTIGATIONAL REPORT No. 27

THE SOUTH AFRICAN PILCHARD

(Sardinops ocellata)

TEMPERATURE VARIATIONS IN THE UPPER 50 METRES IN THE ST. HELENA BAY AREA, SEPTEMBER, 1950 — AUGUST, 1954

BY

M. E. L. BUYS, M.Sc.

(Professional Officer)

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1. Summary.

An account is given of the method used to establish any periodic, and therefore predictable, cycles of temperature within the upper 50 metres layer at 20 stations in the routine research area off the West coast of South Africa. This method comprises the analysis of charts showing the temperature at the surface and at 20 metres, and the mean integral temperature of the 0–50 metres layer on an annual, seasonal and monthly basis.

The variation of these temperatures in time has been graphically represented and analysed by month and by season using the data collected on monthly survey cruises.

The routine area was sub-divided in an attempt to localize any regional effects, and one region, the coastal area, was more critically examined in the light of the available data.

Disappointing results have been achieved so far in the correlation of commercial catch figures and temperature data. It is considered that this failure is, in part, due to uncertainties in the variation of such factors as the strength of the fishing fleet, the selection of the catch owing to market conditions, closed seasons, etc.

2. Introduction.

The growth of the pilchard fishing industry along the West coast of South Africa during the last thirteen years (and especially since 1950) is generally regarded as being phenomenal. Together with the growth of this industry, the need for a sound conservational policy arose, whereby the optimum allowable catch per fishing season could be controlled. In this way the wise exploitation of the fish resource would be assured.

To this end the pilchard research programme was inaugurated in April, 1950, and has since eclipsed all previous activities of the Division of Fisheries. Recently the maasbanker, which has grown tremendously in commercial importance, has been incorporated into the research programme.

The primary aspect of this research programme to date has been the investigation of the biology of the fish and the systematic collection and study of both the biological and physico-chemical environmental data.

Pilchards feed on phytoplankton and zooplankton and occur mainly between 0 and 50 metres in the St. Helena Bay area. The present report is devoted to the study of temperature variations within the upper 50 metres in the area of research and is presented in such a form that correlation with biological data is facilitated. A further aim can be given by quoting Parr (1933) who says: . . . " the biologists are therefore in need of a presentation of the actual facts of oceanography, which will permit them to correlate biological processes with the environmental conditions under which they occur and with the fluctuations in these conditions in point of space and time ", and again " When certain general laws pertaining to the temperature conditions in various sections of the coastal waters here considered seem to be revealed by the analysis of the records given on the following pages, this, of course, merely constitutes a disclosure of facts but not a discovery of their causes ".

3. Area of Investigation.

The area in which data have been collected comprises both the actual fishing grounds and the surrounding waters, from the coastline to the approximate edge of the continental shelf, between 32°S and 33°S. Originally, the area was subdivided into 18 stations and these were designated A, B, C, ... Q, R. In August, 1950, two additional stations, S and T, were added and information obtained at these 20 stations are used as raw material for this investigation. The positions of these stations are shown in Fig. 1.

The bottom topography in the area of investigation (commonly referred to as the *routine area* or the *area*) is relatively simple as can be seen from the contour lines in Fig. 1. Off Saldanha Bay, on the line of stations R–T, the bottom is rocky and slopes sharply at first. In the vicinity of station G a gulley is found which appears to run north-east and then vanishes in shallower depths. Between stations G and T the bottom shallows slightly until the continental slope is reached. Along the line of stations P–A, off St. Helena Bay, the bottom is at first very shallow (inside the Bay) but west of Stompneus Point the depth gradually increases to station Q, where the bottom is very rocky. Farther west the slope appears to be less steep than on the R–G line, until station A is reached, from where it increases quickly towards the edge of the continental shelf.

On the lines of station N–B and M–C the slope of the bottom is even more gentle than along the

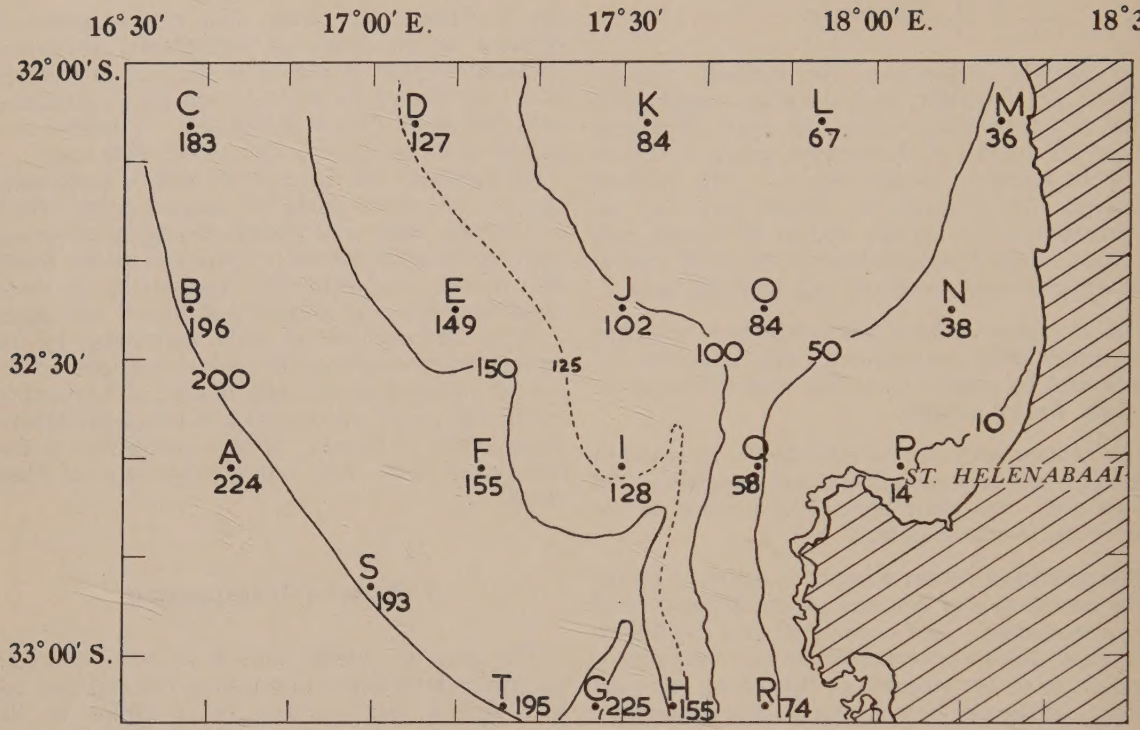

FIG I.—Routine area, showing positions of stations A–T, average soundings and bottom contour profile (in fathoms).

lines of stations previously mentioned and at most of these northerly stations the bottom is covered with a dark-green mud, which contains a certain amount of organic matter, consisting of decayed marine life.

A very good account of other prevailing conditions, such as winds, currents and weather, is given in a previous publication of this Division (Clowes, 1954).

4. Collection of Material.

R.S. *Africana II* has undertaken regular survey cruises in the routine area, usually at least once per month, occupying the whole area in a 4–6 day period depending on weather conditions. At each of the stations serial readings of temperature were taken, and samples were collected for the determination aboard of the inorganic phosphate content and for the determination of salinity ashore. The depths at which observations and samples were obtained were 0, 10, 20, 30, 40, 50, 60, 80, 100, 125, 150, 175, 200, 250, 300 and 400 metres, according to the sounding at the station. Samples for analysis of phosphate were taken at 10 metre intervals to a depth of 50 metres. Reversing thermometers were used during the first period of twelve months but subsequently Negretti and Zambra thermometers were used with the Nansen-Petterssen insulated bottle. All thermometers had been calibrated at the National Physical Laboratory in England, and after all corrections were made, the final readings were considered to have an accuracy of within $\pm$ 0·02°C.

No information on the angle of stray on the wire at individual stations are on record, but R.S. *Africana II* was hove to into the wind, on the occasions when large angles would have been obtained. It is not considered that the wire angle would have any noticeable effect on temperatures used in this report.

5. Selection and Presentation of Data.

The temperatures at two depths as well as an average temperature which is representative of the 0–50 metres layer, have been selected for discussion. These three values are:—

(i) 0 metre temperature.

(ii) 20 metres temperature.

(iii) The mean integral temperature from 0 to 50 metres.

The latter was obtained by averaging the five average values obtained from consecutive layers of 10 metres from the surface downwards as follows:—

$$T_{MI} = \frac{\frac{T_0+T_{10}}{2} + \frac{T_{10}+T_{20}}{2} + \frac{T_{20}+T_{30}}{2} + \frac{T_{30}+T_{40}}{2} + \frac{T_{40}+T_{50}}{2}}{5}$$

$$= \frac{1}{10}(T_0 + 2T_{10} + 2T_{20} + 2T_{30} + 2T_{40} + T_{50})$$

where

T_{MI} = mean integral temperature between 0 and 50 metres.

T_0 = temperature at 0 metres.

T_{10} = temperature at 10 metres, etc.

Temperatures have been tabulated, month by month, season by season and year by year, in chronological order (see appendix). In computing the seasonal values the following conventions were adopted:—

(i) Spring was taken as September, October and November;

(ii) Summer as December, January and February;

(iii) Autumn as March, April and May; and

(iv) Winter as June, July and August.

The fishing industry " commercial catch year " has been taken to be the period from September until the following August. The three sets of temperatures each covering a 48-month period, or four commercial years, will be treated on a separate basis.

Temperature data have been represented as smoothed isotherms drawn every 0·5°C on a series of horizontal charts for the three layers by year, season and month (Plates 1–54).

In addition, graphs have been drawn of temperature variations for months and seasons at individual stations, for the whole of the routine area and for three sub-areas into which the routine area had been divided.

One of the sub-areas, the coastal area, which closely coincides with the commercial catch area, will be dealt with in greater detail.

6. Limitations of Data.

Before discussing the data it must be emphasized that a temperature value tabulated under any specific month, refers to a value derived from one survey cruise in that month except in September, 1950, when all values represent the averages of three separate cruises, and in October, November and December, 1950, February and March, 1951, when the values were averaged from two separate cruises per month. In July, 1951, no cruise was undertaken owing to a lengthy refit of R.S. *Africana II*, and the 1951 winter seasonal values were taken as the average of two months only. To consider values tabulated under a specific month as representing a monthly average of temperature, comparable with averages that could have been computed from daily records, were such records available, might be misleading, as in mid-summer a variation of 2°–3°C has been observed under calm conditions during the course of 24 hours in the 0–20 metres layer close to the coast. Furthermore, the currents along this coast are known to change suddenly and this also brings about sudden changes in temperature.

It is extremely unfortunate that no facilities exist on or off the West coast for daily or semi-daily readings of surface and other temperatures such as are provided by lightship and lighthouse records in the northern hemisphere. If such facilities were available it is considered that accurate local assessments of monthly, seasonal and annual fluctuations of temperature could be made.*

The previous considerations will obviously modify the interpretation of monthly charts and graphs of temperatures and to a lesser extent the seasonal fluctuations, and as it appears, least of all the annual variations, the latter having been considerably smoothed. In drawing temperature charts, it has been assumed that the data for the routine area for any particular month were synoptic, and although moderately consistent temperature patterns are obtained, one is inclined to wonder how many local effects may have been caused by distortion through rapid changes of temperature with time. It is quite possible that on some occasions the representation of data in the charts may be quite different from that showing truly synoptic conditions for the particular period.

7. Acknowledgments.

The author wishes to thank the Director, Dr. J. M. Marchand, the Assistant Director, Mr. C. G. du Plessis, for criticism, advice and encouragement; and Dr. A. J. Clowes, Principal Professional Officer, who read through and corrected the manuscript, for his critical guidance in the compilation of the report. I am grateful also to Dr. D. H. Davies, Senior Professional

* Tentative arrangements are now being made to instal a continuous temperature recorder at the Stompneus fish jetty, and it is hoped that this recorder will be of some aid in increasing our knowledge of the local changes in temperature.

Officer and to Mr. B. v. D. de Jager, Professional Officer for useful suggestions and discussions. Then the heartiest appreciation must be expressed towards all the officers, scientists and men aboard R.S. *Africana II*, whose patience, endurance and effort often under trying circumstances made it possible to collect all the material that has been used.

8. Temperature Charts.

A. Annual Averages.

(i) 0 Metres.

On comparing the surface isotherms for each commercial year (Plate 1) it is seen that, despite the limitations of the data previously mentioned, the annual patterns are strikingly similar.

In 1950/51 the average temperature varied throughout the area from 13·5° to 17·5°C, i.e. a range of 4°C. During 1951/52 the range was the same but on average the surface water was 0·5°C colder than in 1950/51. In the following year, 1952/53, a slight local change in pattern took place, since the northerly stations M and N were warmer than before and the coldest part centred around station Q. The range decreased from 4°C to 3°C, i.e. from 13·5° to 16·5°C in this year. The cold centre around this station had disappeared in 1953/4, when the range in temperature was found to be 3·5°C, i.e. from 13·5°C to 17°C.

(ii) 20 Metres.

At this depth a repetition of the basic pattern seen at 0 metres was found (Plate 2), but the temperature range over the routine area had increased and was from 11° to 17·5°C in 1950/51, 11°–17°C in 1951/52, 11·5°–16°C in 1952/53, and 11·5°–16·5°C in 1953/54.

The increase in the range of temperature over the area at 20 metres, compared with the range of the surface temperature, is due to a tighter vertical packing of isotherms between 0 and 20 metres as the coast is approached. The difference at individual stations between the surface temperature and the temperature at 20 metres increases on an average, as one moves coastwards from west to east in the routine area.

(iii) 0–50 Metres.

In general the same basic pattern of isotherms, which is present at the surface and at 20 metres is also found in the chart of the annual temperature averages of the 0–50 metres layer for each of the 4 years (Plate 3).

The ranges of the 0–50 metres mean integral temperature were 5·5°C in 1950/51 (11·5°–17°C) and in 1951/52 (11°–16·5°C), 4° in 1952/53 (12°–16°C) and 5° in 1953/54 (11·5°C–16·5°C).

It appears that smaller variations in temperature at the surface, and at 20 metres and in the 0–50 metres layer were experienced in 1952/53 than in any of the other three years. If all surface, 20 metres and 0–50 metres temperatures taken over the routine area during a commercial year are separately averaged and compared with the corresponding four-year average, it appears that 1953/54 was colder than " average ", 1951/52 and 1952/53 were approximately " average ", and 1950/51 was slightly warmer than the " average ", i.e. if one could assume that the mean of 47 months represents an accurate " average " figure (see Table 1).

TABLE I.

Year.	1950/51.	1951/52.	1952/53.	1953/54.	Average.
0 metres	15·56	15·42	15·49	15·17	15·41
20 metres	14·50	14·33	14·41	14·05	14·32
0–50 metres	14·32	14·21	14·17	13·94	14·16

B. Seasonal Averages.

Spring

(i) 0 Metres.

The surface isotherms for spring vary considerably from year to year in the period under review (Plate 4). The 17° and 16°C lines, present towards the western boundary in 1950, do not appear within the limits of the area during 1951. Both the 15° and 14°C isotherms moved westward from 1950 to 1951 and the temperature range decreased from 3°C (14°–17°C) to 2°C (13·5°–15·5°C). The decrease in range continued from 1951 into 1952 for the larger part of the routine area where it was only ± 1°C or from 15·5°–16·5°C and, only in a smaller

area, near to the coast in the region around station Q was a further extension in this range found (i.e. from 14°–15·5°C); this was probably due to a small patch of upwelled water in that particular zone. The range of temperature increased to 4·5°C (12°–16·5°C) over the whole area in spring 1953, when temperatures along the coastal belt were particularly cold for spring.

On comparing the averages taken over the whole area for this season, it appears that the surface was considerably colder in spring 1951, and also in 1953, than in the other two years. In 1951 the lower temperatures could probably be ascribed to the persistence of wintry conditions, whereas in 1953 the low temperatures were undoubtedly due to early upwelling along the coast.

(ii) 20 Metres.

A more general mutual similarity is noticed when the four spring isotherm charts at 20 metres are compared (Plate 5) than was the case with the surface charts.

Temperature ranges were from 11° to 16·5°C in 1950, 11·5° to 15°C in 1951, 11·5° to 16·5°C in 1952, and 10·5° to 16°C in 1953. Two of the patterns are in particular agreement, viz. those of 1950 and of 1952. The isotherm diagram for spring 1951 seems to bear out the late persistence of wintry conditions during this year. Furthermore, in 1953, temperatures near to the coast were, as at the surface, colder than in the other years, pointing to early upwelling.

By comparison, it may be seen that the difference between the surface and the 20 metres temperatures increases progressively coastwards in this season.

(iii) 0–50 Metres.

The remarks made in discussing the 20 metres temperatures in the preceding paragraphs are also applicable to the 0–50 metres temperatures (Plate 6).

Summer.

(i) 0 Metres.

A general warming at the surface since spring is noticeable. The average temperatures recorded on the western boundary of the area (Plate 7) amount to 18°–19°C, whereas inshore the temperatures range from 13°–14°C, which would appear high when it is borne in mind that upwelling is to be expected most frequently in summer. The decrease in temperature, associated with upwelling of cold, deeper waters, appears to have been more than compensated for by the increase in solar radiation during the summer months. Water with a temperature of *circa* 17°C is sometimes found to be overlying colder water of *circa* 10–11°C at 20 metres near to the coast. This surface film of light warm water is formed in summer under calm conditions, and represents the so-called" thermocline layer ", which is very difficult to destroy completely unless strong winds blow consistently for prolonged periods. Once the wind decreases in strength the thermocline layer is re-established. *For these reasons the 20 metres temperature, especially in summer and generally throughout the whole year, is considered to be a better indicator of upwelling phenomena which are easily masked at the surface by radiation effects.*

In 1951/52 the temperature at the surface in summer was higher than in any of the other three years. The pattern of the different isotherms for the four summers appears to be only vaguely similar, and the temperature ranges are 13·5° to 18°C in 1950/51, 13·5° to 19°C in 1951/52, 13° to 18°C in 1952/53 and 13° to 19°C in 1953/54.

(ii) 20 Metres.

The temperature gradient between the surface and 20 metres, which increased slightly at the deeper stations, has steepened nearer to the coast. The increase of gradient near the coast will be considered in detail later in the report as it may be of some importance in determining the actual relation of the physical environment to biological phenomena.

At this depth the 14°C isotherm appears in the same locality in all four years, and seems to act as a boundary between the deeper and shallower stations (Plate 8). The isotherms are more tightly packed east of this isotherm than towards the west.

A large area close to the coast was demarcated by the 10°C isotherm in 1953/54 whereas in the other years this particular value was found only in the immediate vicinity of Station P. The average temperatures for all stations during the summer months show that 1953/54 was the coldest year (13·67°C). Other summer averages were 14·12°C in 1950/51, 14·98°C in 1951/52 and 14·21°C in 1952/53. This suggests more intense upwelling in 1953/54 than in any other of the three years.

(iii) 0–50 Metres.

In the 0–50 metres layer, for the four-year period, the lowest temperatures were recorded in summer

1953/54, when the 10°C line appeared in the area immediately to the west of stations M and N (Plate 9). This area is usually characterized by temperatures of about 11°C. In 1951/52 the 17° and 18°C isotherms, particularly the former, were prominent on the outer, or western, side of the area; the only other time that the 17°C isotherm appeared during this season was in 1953/54, when its area of intersection with the boundary of the routine area was relatively small.

In agreement with the findings noted at 20 metres the temperature of the 0–50 metres layer in summer was higher in 1951–52 and lower in 1953/54, than in either 1950/51 or 1952/53.

Autumn.

(i) 0 Metres.

In the surface the distribution of isotherms differs considerably from year to year in this season. In 1951, temperatures ranged from 14°–19°C; in 1952 from 12·5°–18·5°C; in 1953 from 14·5°–17·5°C and from 13·5°–18°C in 1954 (Plate 10). Autumn temperatures were higher in the off-shore zone in 1951 than in any other year, and the mean surface temperature for all stations during this season was higher than the corresponding average figure for the preceding summer (1950/51). In 1952 a local patch of cold water occurred in the vicinity of station M. In 1953, signs of mixing appear during this season as can be seen from the decrease in the number of isotherms in the routine area. The average temperature of all stations, in the autumn season showed relatively small variation from one year to another and was 16·00°C in 1951, 15·85°C in 1952, 16·05°C in 1953 and 16·08°C in 1954.

(ii) 20 Metres.

The temperature difference between the surface and 20 metres has decreased considerably in the western, more off-shore zone, but still persists to a moderate extent nearer the coast (Plates 10 and 11).

Though average temperatures show little change in this season from year to year, it does seem that along the coast itself in 1952 autumn was slightly colder than in any of the other three years.

This season is generally the most important as far as the commercial catches of pilchards are concerned. The possibility exists that the stable conditions as a result of the relatively calm weather generally experienced off the West coast in this season (Clowes, 1954), may be an important contributing factor to the presence of large numbers of pelagic fish.

(iii) 0–50 Metres.

With certain local variations, the basic pattern of isotherms is repeated in this layer, but individual values vary in parts throughout the four years (Plate 12). The range of temperature in the four years was as follows: 1951, from 11·5° to 19°C; 1952, from 10·5° to 17·5°C; 1953, from 12° to 16°C and in 1954, from 11·5° to 17·5°C. The same remarks apply to the 0–50 metres, as were made for the 20 metres temperatures.

Winter.

(i) 0 Metres.

At the surface, the isotherms during winter are few in number and inclined to meander (Plate 13). This season is characterized by minimal solar activity, but considerable vertical and, to a lesser extent, horizontal mixing takes place, due to the prevailing westerly winds. Temperature ranges were from 13° to 16·5°C in 1951, 13° to 16·5°C in 1952, 13° to 15·5°C in 1953, and from 13° to 15°C in 1954.

(ii) 20 Metres.

The temperature range at 20 metres depth was again found to be larger than at the surface, from 13° to 16·5°C in 1951, 12° to 16°C in 1952, 12° to 15°C in 1953 and from 13° to 15°C in 1954. The temperature gradient that usually exists between 0 and 20 metres reaches its minimum in winter. Readings at individual stations, especially those farther off shore, reflect uniform temperatures over the upper 50 metres during this season.

(iii) 0–50 Metres.

Striking agreement in the distribution of isotherms at 20 metres with those over the depth range 0–50 metres is recorded (Plates 14 and 15).

C. Seasonal Cycle.

(i) Surface Temperatures (Plate 16).

On calculating the average value for spring, summer, autumn and winter, for each station, from the four values for every year (Table II), plotting these values, and charting the isotherms, the following basic seasonal changes emerge:—

A wide scattering of isotherms over the whole area is found during the average winter season. The temperatures at stations L, M, N, O, P and Q or at the majority of the coastal stations, show particularly close agreement with one another.

Towards spring the 15° and 16°C isotherms, found off shore in winter tend to shift towards the coast, and around Stompneus Point (Station Q) isotherms tend to crowd. This crowding increases towards summer, due to the entrance of the 17° and 18°C isotherms in the western part of the area and to the movement of the 15° and 16°C isotherms towards the coast. The 17° and 18°C isotherms persist into autumn, in approximately the same zone, and the area containing the maximum horizontal temperature gradients moves slightly farther off shore, leaving the coastal belt almost isothermal, with a slightly higher temperature. An almost abrupt transition takes place in temperature conditions from autumn to winter, particularly in the off-shore zone, where the 17° and 18°C isotherms move outside the limits of observation, with the result that horizontal temperature gradients are appreciably decreased.

TABLE II.

4-YEARS SEASONAL AVERAGE OF TEMPERATURE, °C.

Station.	Surface Temperature.				20 Metres Temperature.				0–50 Metres Temperature.			
	Spring.	Summer.	Autumn.	Winter.	Spring.	Summer.	Autumn.	Winter.	Spring.	Summer.	Autumn.	Winter.
A.....	16·15	18·23	17·93	15·85	15·84	17·47	17·25	15·74	15·74	16·95	16·97	15·62
B.....	16·22	17·73	18·28	15·68	15·97	16·80	17·65	15·62	15·86	16·34	17·01	15·53
C.....	15·81	18·14	17·54	15·51	15·46	16·98	16·41	15·41	15·39	16·61	16·98	15·37
D.....	15·21	16·71	16·18	14·72	14·69	15·34	15·22	14·56	14·49	14·83	14·68	14·32
E.....	15·53	16·82	16·61	14·73	15·02	15·50	15·31	14·70	14·80	15·03	14·81	14·42
F.....	16·01	16·64	16·39	15·24	15·53	15·54	15·39	15·09	15·35	14·97	14·71	14·89
G.....	16·11	17·24	17·37	15·64	15·61	16·31	16·65	15·40	15·58	15·68	15·97	15·21
H.....	15·64	15·64	15·69	14·86	15·16	14·15	14·36	14·61	14·97	13·77	13·92	14·63
I.....	15·13	15·64	16·25	14·98	14·55	14·45	14·71	14·86	14·29	13·99	14·05	14·50
J.....	15·12	15·86	15·57	14·59	14·53	14·71	14·51	14·51	14·26	14·11	13·94	14·24
K.....	14·64	15·33	15·18	13·89	13·61	13·60	13·68	13·59	13·42	13·12	12·91	13·27
L.....	14·31	14·92	15·05	13·37	13·04	12·44	12·52	12·93	12·23	11·87	11·95	12·35
M.....	13·41	13·67	14·21	12·78	11·10	10·11	11·89	12·22	11·10	10·44	11·58	12·00
N.....	13·99	13·93	14·28	13·07	11·96	10·52	11·83	12·51	11·57	10·53	11·64	12·11
O.....	14·31	14·59	14·43	13·69	13·35	12·89	13·05	13·32	12·83	12·22	12·56	12·77
P.....	13·95	13·45	13·98	13·23	11·11	9·20	11·06	12·52	—	—	—	—
Q.....	13·23	13·19	14·25	13·19	12·16	11·58	11·95	12·67	11·57	11·06	11·84	12·32
R.....	14·09	14·41	14·22	14·16	13·23	12·32	12·50	13·94	12·72	12·00	12·27	13·47
S.....	16·35	18·47	18·31	16·07	16·09	17·41	17·84	15·92	15·97	16·88	17·65	15·87
T.....	16·39	18·35	18·16	15·94	16·15	17·64	17·51	15·81	16·02	17·07	17·11	15·78

(ii) 20 Metres Temperature (Plate 17).

At this depth, in winter, isotherms are more widely spaced than in any other season as at the surface. On passing into spring isotherms draw together in the south-eastern part of the routine area. The 16°C isotherm moves into the area on the south-western boundary. Towards summer the isotherms crowd near the coast, as a result of the appearance of colder water at the coast and warmer water farther off shore, moving eastwards as shown by the appearance of the 17°C line. In autumn a general increase in temperature in the coastal zone is found, while the temperatures in the intermediate and outer areas appear to be fairly constant. Towards winter the 17° and 16°C isotherms disappear outside the limits of observation and farther inshore warming takes place at this depth. The temperature gradient between 0 and 20 metres is always minimal in winter and maximal during summer for these four years.

(iii) 0–50 Metres Temperature (Plate 18).

The same changes take place from one season to another, as mentioned in discussing the 20 metres temperature.

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9. Seasonal Commercial Catches for Period under Review.

In Table III the monthly and seasonal catch figures for pilchards and maasbankers, based on factory returns from January, 1951, to August, 1954, are given. Data prior to January, 1951, are not considered accurate enough to warrant inclusion.

It must be stressed that these figures do not reflect the catch per unit effort, which is conventionally used as an indication of the relative abundance of a commercial fish species. Data on the amount of effort expended by the pilchard and maasbanker fishing fleet are not available and therefore no attempt could be made to relate the catch to the catch per unit effort. Thus it was not possible to correlate the relative abundance of pilchards and maasbankers with their environment. Nevertheless it is interesting to examine the possible relationship between the catch figures and the sea temperature.

TABLE III.

TOTAL CATCH FIGURES (IN SHORT TONS).
January, 1951–August, 1954.

Month/Season.	1951.		1952.		1953.		1954.	
	Pilchard.	Maas-banker.	Pilchard.	Maas-banker.	Pilchard.	Maas-banker.	Pilchard.	Maas-banker.
January	484	15,924	2,480	17,413	537	19,824	65	—
February	1,201	18,664	12,151	24,903	17,793	20,011	1,756	25,323
Summer	Incomplete data		15,053	46,360	18,442	43,825	1,821	25,323
March	8,208	12,911	33,145	9,167	34,284	11,375	3,282	17,546
April	11,637	9,795	41,788	7,941	22,645	3,711	5,512	22,092
May	14,636	15,096	27,864	7,515	38,008	4,673	14,721	17,787
Autumn	34,481	37,802	102,797	24,623	94,937	19,759	23,515	57,425
June	15,665	5,384	15,552	9,910	7,312	13,638	37,918	12,895
July	25,022	10,593	28,422	9,884	10,340	10,752	18,335	19,681
August	22,529	3,366	7,825	572	4,602	4,760	8,922	13,956
Winter	63,216	19,343	51,799	20,366	22,254	29,150	65,175	46,532
September	*	1,868	†	†	15,466	4,396	—	—
October	*	453	†	†	‡	‡	—	—
November	9,806	13,194	18,085	21,841	‡	‡	—	—
Spring	9,806	15,515	18,085	21,841	15,466	4,396	—	—
December	422	4,044	112	3,990	‡	‡	—	—

* Closed season for pilchards: 1/9/1951 to 31/10/1951.
† Closed season for pilchards and maasbankers: 1/9/1952 to 31/10/52.
‡ Closed season for pilchards and maasbankers: 15/9/1953 to 31/12/1953.

These figures must necessarily be considered with caution, especially as closed seasons were in operation periodically, as indicated by the footnotes in Table III.

From this information it may be seen that generally—

(*a*) pilchard catches are maximal in autumn to winter, and minimal in spring to summer;

(*b*) maasbanker catches are maximal in summer, whilst isolated good catches are made in spring and autumn.

The two seasons of maximum pilchard catches are characterized by a lack in horizontal and, to a lesser extent, vertical temperature gradients in the upper 20 metres within the catch area. The season of maximum catches of maasbanker seems to be associated with the presence of strong vertical

and horizontal gradients within the catch area, which approximately corresponds to the coastal zone. Whether the homogeneous temperature conditions in the case of the pilchard, and the heterogeneous conditions in the case of the maasbanker, are essential or merely coincidental to the appearance of large shoals of the respective species is, at this stage, a matter of conjecture, but the coincidences are striking enough to warrant further investigation.

10. Monthly and Seasonal Variation.

A. Monthly Variation.

(i) Whole of the Routine Area.

At the outset of the pilchard research programme, it was thought that if the average values of the surface, 20 metres and 0–50 metres temperatures for the 20 stations in the routine area were determined from month to month and that if these values were plotted graphically against time, one or more of these graphical representations would show typical temperature cycles for the upper 50 metres which would be repeated from one year to another. Unfortunately these graphs do not show any clearly defined annual cycles, and the variations appear erratic (Plate 68). It is thought that the irregularity of the variations is due either to the lack of more comprehensive data or to the fact that temperature phenomena exhibit different trends in different parts of the routine area. If, for example, moderate southerly winds blow for a relatively short period along the coast, the resultant upwelling may be of a limited nature and, though stations near to the coast may be cooled considerably, stations farther off shore may not be affected at all, or, if they are, at a much later stage, may even show an increased temperature in midsummer. In this way the 20-station average may either show a cooling effect, or may actually show an increase in temperature, from one month to another, in spite of coastal upwelling. Local effects may therefore be of considerable importance, and could either dominate the average, or may not be ascertainable at all.

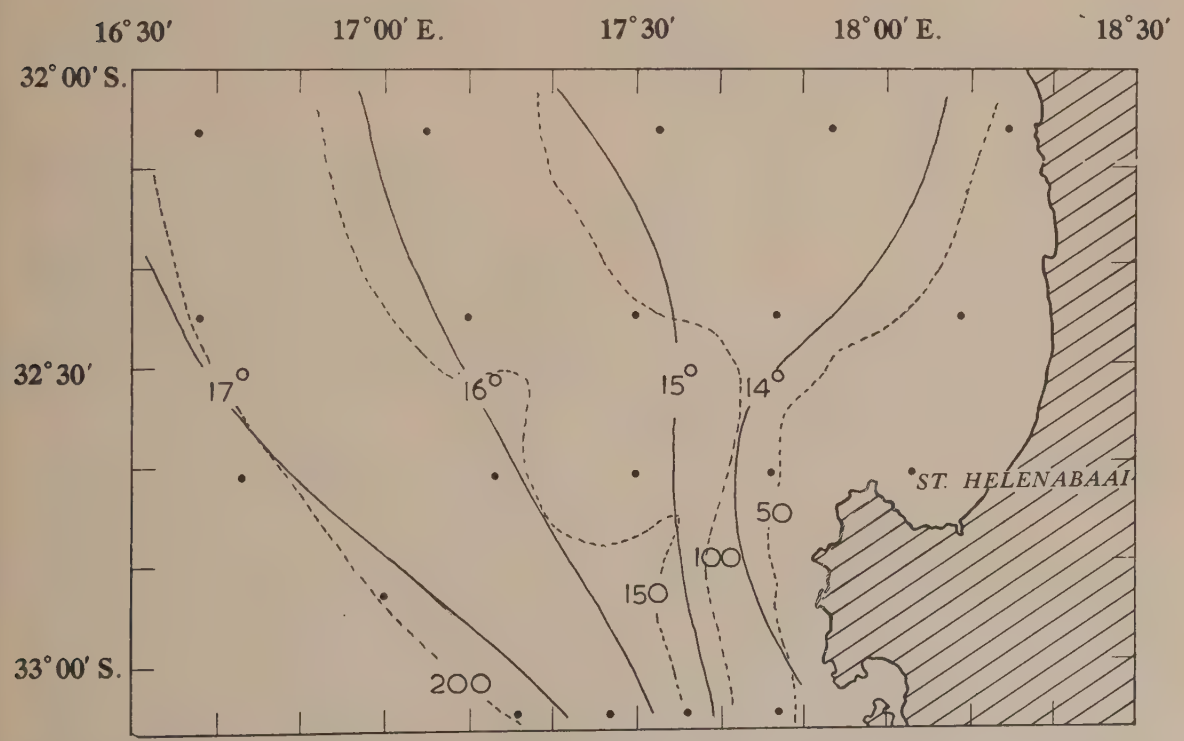

FIG II.—Relationship between 4-year average surface temperature and bottom contours in fathoms (dotted lines).

From the experience gained of temperature conditions of the waters in the routine area, and in agreement with the basic principles of dynamic oceanography, it is known that *in general*—

(*a*) temperature values decrease from west to east along the same line of latitude as denser and colder waters are (in the Southern Hemisphere) found to the right of the prevailing northsetting currents along the West coast;

(*b*) lines of equal surface temperatures (isotherms) coincide very roughly with lines of current flow.

From these considerations, a sub-division of the routine area into sub-areas, with more comparable temperature conditions, appeared to be quite logical as the next step in unravelling the cycle of temperatures. The sub-division was effected by choosing as boundaries between adjacent areas streamlines which divide the routine area into three sub-areas with approximately the same number of stations in each one.

If the average surface temperatures at individual stations are computed, over the four-year period, and the isotherms are charted (see Fig. 2) together with the bottom contour lines, it is seen that the isotherms coincide fairly closely with the contour lines. To effect the sub-division of the area in a convenient way, therefore, the soundings were used.

The following grouping was adopted:—

(*a*) *Outer area.* Stations A, B, C, G, S and T.

(*b*) *Intermediate area.* Stations D, E, F, H, I, J and K.

(*c*) *Coastal area.* Stations L, M, N, O, P, Q and R.

The average values of temperature (monthly, seasonal and annual) were computed according to this grouping for the three areas, and are considered separately.

(ii) Outer Area.

In the outer area, a definite annual temperature cycle at the surface, 20 metres and for the 0–50 metres layer may be seen (Plate 67). Peaks occurred in May, 1951, and thereafter in January, 1952, January, 1953, and February, 1954. Minimal values of the temperature at these three depths appear mainly in August. A secondary minimum, however, is recorded at the surface and for the 0–50 metres layer in February, 1951, and at 20 metres in January, 1951.

In general, therefore, maximum temperature can be expected in the outer area in January–February (or in midsummer) and minimum temperature in August, i.e. in late winter.

(iii) Intermediate Area.

In the surface well-defined temperature maxima appear in January, 1952, and February, 1954. In 1951 the maximum value is recorded in May, but no clear maximum is shown at all from October, 1952, to May, 1953, when fluctuations in temperature were rather violent from one month to another (Plate 67). Minima are shown in March, 1951, and 1952, September, 1951, August, 1952, February, 1953, August, 1953, December, 1953 and August, 1954.

At 20 metres, maximum temperatures are recorded in May, 1951, January, 1952, January, 1953, (not very distinct) and in May, 1954. Minima occur haphazardly and frequently, probably being rather more dependent on weather conditions than on the actual solar season.

No apparent cycle of temperature is discernible in the 0–50 metres layer, and the temperature of this layer remains remarkably constant from May, 1953, to August, 1954, at $\pm$ 14°C.

(iv) Coastal Area.

Temperature maxima are found to occur at the surface in October, 1950, May, 1951, February, 1952, November, 1952, March, 1953, September, 1953 and March, 1954. This tends to show that biannual peaks occur in months of the spring and autumn seasons, when the least wind action may be expected off the West coast. The large difference between the 0 and 20 metres temperatures on these occasions further suggests that local solar heating of the surface layer is the agent causing the peaks.

Minimum temperatures at the surface appear in November, 1950, March, 1951, July, 1952, February, 1953, October, 1953 (well-defined) and April, 1954.

At 20 metres, maximum temperatures occur in May, 1951, September, 1952, and March, 1954, with secondary, ill-defined peaks in other months. Minima at 20 metres occur in November, 1950, March, 1951, November, 1951, February, 1953, and October to March, 1954.

In the 0–50 metres layer, temperatures are highest in May, 1951, September, 1952, April, 1953 and July, 1954, and lowest in November, 1950, March, 1951, November, 1951, February, 1953 and October, 1953.

The variations of the surface, 20 metres and 0–50 mean integral temperatures are compared for the three areas in Plates 79–81, where it is seen that on many occasions opposite tendencies were recorded from one month to another in the different areas.

(v) Individual Stations.

Graphs of temperature variations for individual stations are also included in this report (Plates 69–78), but as these data appear very confused, especially at stations near to the coast, no analysis of them will be attempted.

It would appear, however, that variations in temperature caused by meteorological conditions affect the outer stations to a much lesser extent than those nearer to the coast. Tidal action, vertical mixing, and solar activity along the coast all appear to superimpose their effect on whatever annual cycle of temperature may have existed, and it is therefore obvious that at these stations, which represent the immediate environment of the fish shoals which are actually exploited, a single set of temperature data per station, per month is insufficient to establish any possible relationship between the monthly catch figure and the environmental temperature.

B. Seasonal Variation.

(i) Whole of the Routine Area.

(*a*) Surface Temperatures.

Maximum temperatures occur in autumn, 1951, summer, 1951/52, probably in summer, 1952/53 and in autumn, 1954. Minima are present in spring, 1951, winter, 1952, winter, 1953 and winter-spring, 1954.

(*b*) 20 Metres.

The variations are considered too small to be of significance.

(*c*) 0–50 Metres.

Same as for (*b*).

(ii) Outer Area.

On sub-division the appearance of a regular seasonal rhythm is observed for the surface, 20 metres and 0–50 metres in the outer area. Maximum temperatures occur in summer to autumn; minima in winter to spring.

(iii) Intermediate Area.

(*a*) Surface.

Well-defined temperature maxima occurred in summer, 1951/52 and in autumn, 1954; whilst weak or ill-defined maxima occurred in summer, 1950/51, spring, 1952 and autumn, 1953.

Minima occurred in winter–spring, 1951 and in the winter of 1952, 1953 and 1954.

(*b*) 20 Metres and 0–50 Metres.

Maximum and minimum temperatures occurred irregularly and were not always well-defined.

(iv) Coastal Area.

(*a*) Surface.

A weak temperature maximum occurred at the surface in autumn, 1951; clearer maxima were found in summer, 1952, spring, 1953 (with a secondary maximum in autumn, 1953) and in autumn, 1954.

Minima occurred in spring, 1951 (weak), winter, 1952 and spring, 1953. A secondary minimum occurred in summer, 1952/53.

(*b*) 20 Metres.

Maximum temperatures were found in winter, 1951, spring, 1952, autumn–winter, 1953 and winter, 1954.

Minima were present in summer, 1950/51, summer–autumn, 1952, summer, 1952/53 and summer, 1953/54.

(*c*) 0–50 Metres.

The mean integral temperature of the 0–50 metres layer varied in the same manner as at 20 metres, except that the minimum temperature found in summer, 1953/54 at 20 metres was a season earlier at 0–50, viz. in spring, 1953.

If the 20 metres temperature is used as criterion, it would appear that the seasonal cycle of temperature at coastal stations is actually an inversion of the cycle observed along the outer stations. This fact could have been expected as a result of the secondary effect of prevailing south-easterly winds in summer and north-westerly winds in winter.

As the intermediate area appears to be periodically invaded by waters from either the coastal or outer zones, the general lack of a defined temperature cycle is not surprising. It may also be seen that the average seasonal values of all stations coincide very closely with the corresponding seasonal values of the intermediate area (Fig. III).

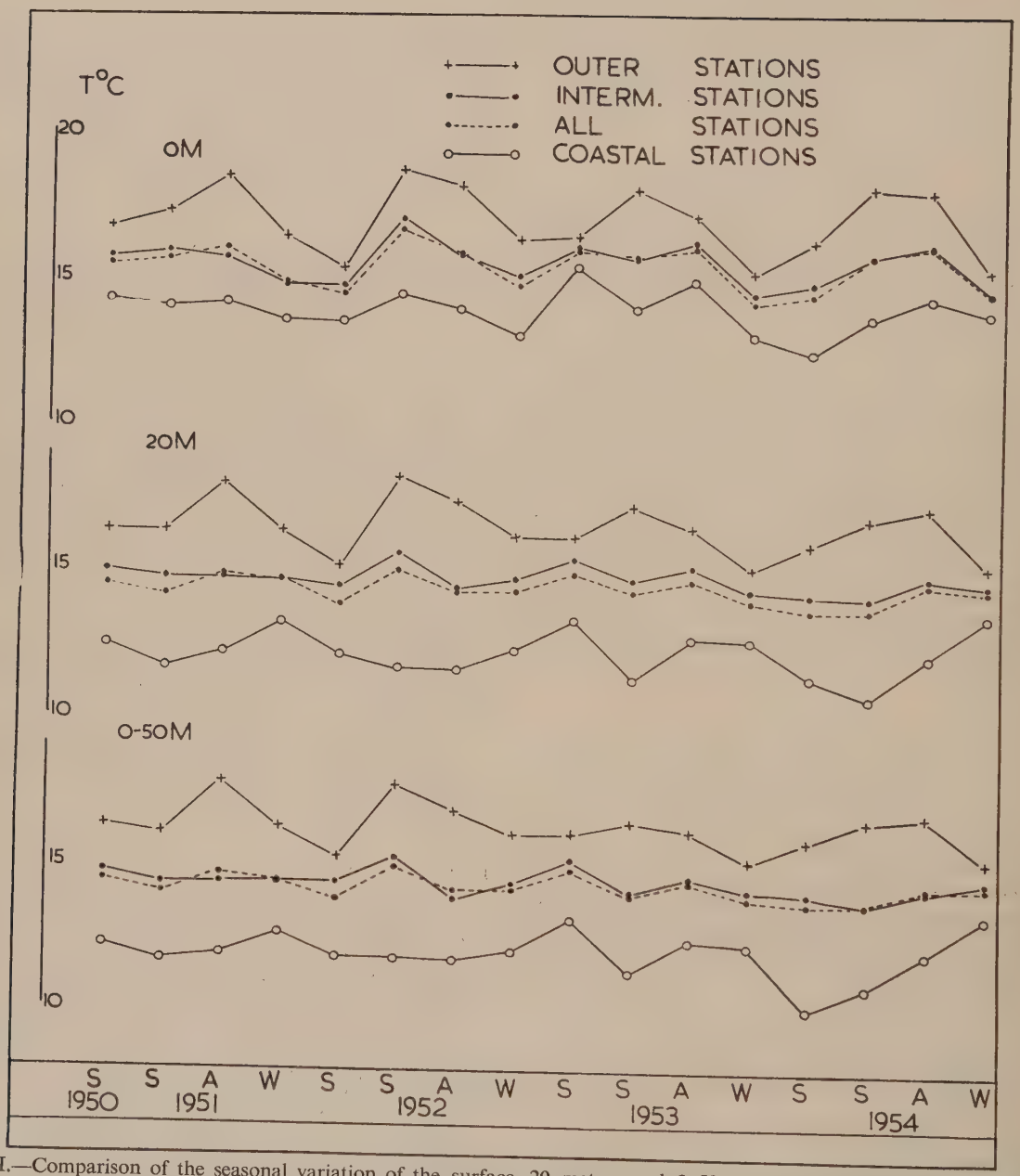

FIG III.—Comparison of the seasonal variation of the surface, 20 metres and 0–50 metres mean integral temperature for outer, intermediate, coastal and whole routine area.

From Fig. III it is also seen that temperature trends off shore frequently differ from those in the intermediate and coastal zones.

(v) Individual Stations.

Table IV gives the seasons of maximum and minimum temperatures in the 4-year period. If no clear maximum or minimum could be seen the remark " indistinct " applies. If consecutive maxima (or minima) follow each other after alternate seasons, or haphazardly, the designation " variable " is inserted.

TABLE IV.

SEASONS OF MAXIMUM AND MINIMUM TEMPERATURE.

Station.	Surface Temperature.		20 Metres Temperature.		0–50 Metres Temperature.	
	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.
A.....	Summer	Winter	Summer/autumn	Winter	Summer/autumn	Winter.
B.....	Summer/autumn	Winter	Autumn	Winter	Autumn	Winter/spring.
C.....	Summer	Winter	Summer	Winter/spring	Summer	Winter/spring.
G.....	Autumn	Winter	Autumn	Winter/spring	Summer/autumn	Indistinct.
S.....	Summer/autumn	Winter/spring	Summer/autumn	Winter/spring	Summer/autumn	Winter/spring.
T.....	Summer/autumn	Winter/spring	Summer/autumn	Winter/spring	Summer/autumn	Winter/spring.
D.....	Summer	Winter/spring	Summer	Spring	Summer	Spring.
E.....	Summer/autumn	Winter	Summer/autumn	Indistinct	Indistinct	Indistinct.
F.....	Summer/autumn	Winter	Indistinct	Indistinct	Indistinct	Indistinct.
H.....	Indistinct	Indistinct	Indistinct	Summer/autumn	Spring	Variable.
I.....	Variable	Winter/spring	Winter	Indistinct	Winter	Variable.
J.....	Summer	Winter/spring	Summer/autumn	Variable	Variable	Variable.
K.....	Summer	Winter	Variable	Variable	Winter/spring	Variable.
L.....	Summer/autumn	Winter/spring	Indistinct	Indistinct	Indistinct	Indistinct.
M.....	Autumn	Spring	Winter	Summer	Autumn/winter	Summer.
N.....	Variable	Winter/spring	Winter	Summer	Winter	Summer.
O.....	Summer	Winter/spring	Indistinct	Indistinct	Indistinct	Indistinct.
P.....	Indistinct	Indistinct	Winter	Summer	—	—
Q.....	Indistinct	Indistinct	Indistinct	Indistinct	Indistinct	Indistinct.
R.....	Indistinct	Indistinct	Winter	Summer/autumn	Winter	Summer/autumn.

The findings in the above table confirm the previous finding that the cycle of the temperature at 20 metres at coastal stations is an inversion of that found at the outer, deeper stations.

II. Coastal Stations.

(i) The Difference between Surface and 20 Metres Temperatures.

In a previous part of this report (p. 675) it was stated that the difference between the surface and the 20 metres temperature increased progressively coastwards, i.e. from west to east.

This phenomenon depends on the existence of the thermocline, the region in which the rate of change of the temperature with increasing depth is greater than in the layers above or below it. Farther off shore, the thermocline is present at depths of *circa* 50–120 metres, but near to the coast it is found very near the surface, i.e. between 0 and 30 metres.

Proudman, 1953 (p. 196) remarks: "The relatively high temperature-gradient involves a relatively high vertical density-gradient, and this produces relatively high vertical stability and relatively little vertical turbulence".

Along this coast the relatively high stability is especially found in summer when the action of sunlight is at its maximum, and the sun's effect is then mainly limited to the thin surface layer of water, especially in periods of calm. An interesting example of this vertical stability was recorded in January, 1955, when a special 24-hour anchor station was worked by R.S. *Africana II* at Station N (*position*: latitude 32° 25′ S, longitude 18° 09′ E). The temperatures at the surface, 20 and 30 metres at consecutive intervals of approximately 3 hours have been selected and are given in Table V.

TABLE V.

Time.	0 hrs.	3 hrs.	6 hrs.	9 hrs.	12 hrs.	15 hrs.	18 hrs.	21 hrs.	24 hrs.
0 metres....	17·64	16·69	15·69	14·82	15·00	15·48	15·45	16·42	16·78
20 metres....	11·16	10·58	9·61	9·66	9·59	9·63	9·65	9·82	9·70
30 metres....	9·30	9·17	9·15	9·14	9·10	9·11	9·11	9·06	9·06

Table V shows that over the period of 24 hours, starting at approximately midday, the surface temperature varied considerably, the 20 metres temperature relatively less, whereas hardly any change took place in the temperature at 30 metres. Little or no wind was recorded for the duration of the anchor-station, and thus a minimum amount of mixing due to wind took place in the surface layers. As the temperatures were recorded in mid-summer, it is felt that these variations in temperature represent approximately a maximum for this particular position, and for other similar positions, under relatively calm and cloudless conditions. These variations are graphically represented in Fig. IV.

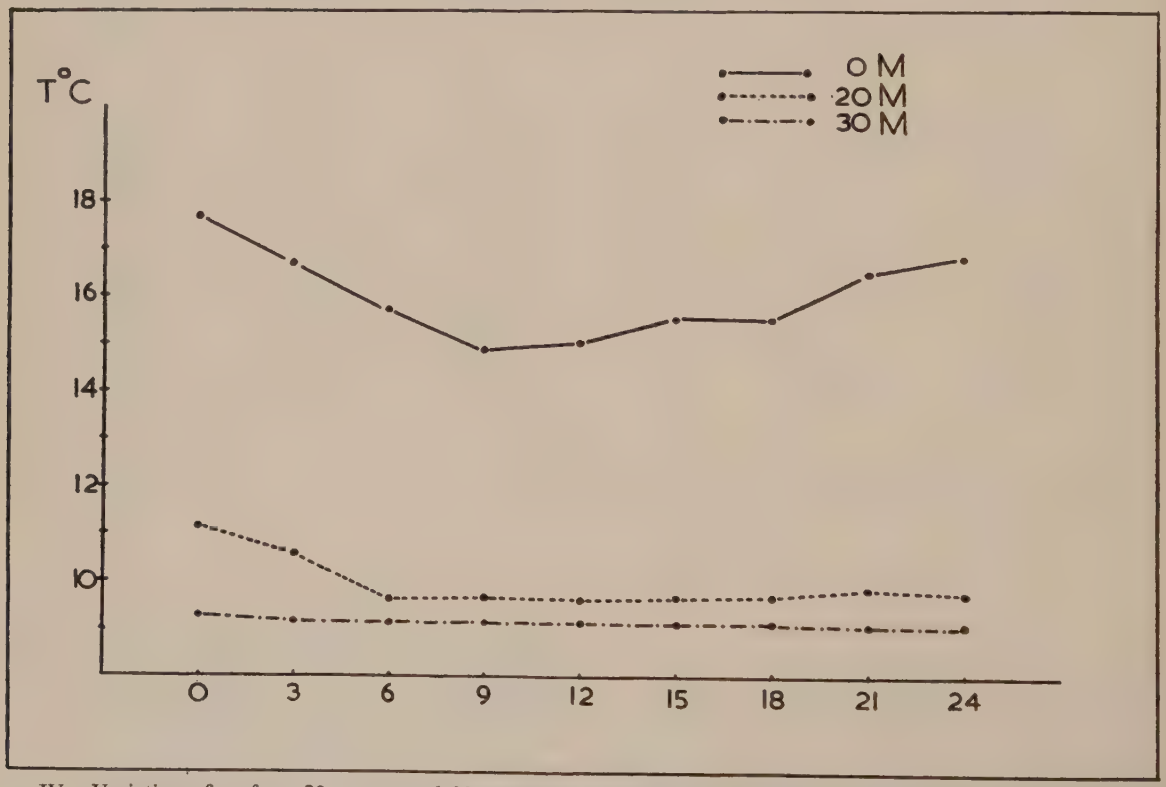

FIG. IV.—Variation of surface, 20 metres and 30 metres temperature during a 24-hour anchor station, St. Helena Bay, January, 1955.

The difference in temperature between surface and 20 metres, during the 24 hours at the anchor-station, was 5°–6°C, depending on the time of the day when temperatures were recorded. It seems unlikely that during the summer, in spite of the action of the usually prevailing southerly winds, this gradient between 0 and 20 metres will be completely destroyed, although obviously it would not always be as high as 6°C. If the upper layers by chance through violent wind action, become homothermal it is more than likely that this condition would be of a very brief duration.

As confirmation of the above, the seasonal differences in surface and 20 metres temperatures of the coastal stations have been calculated and are shown in Table VI.

TABLE VI.

SEASONAL DIFFERENCE °C BETWEEN TEMPERATURE AT 0 AND 20 METRES.

Season.	1950/51.	1951/52.	1952/53.	1953/54.
Spring....	1·80	1·42	2·11	1·14
Summer...	2·39	2·82	2·70	3·00
Autumn...	1·99	2·37	2·26	2·32
Winter....	0·40	0·78	0·44	0·33

From this table and Fig. V the difference between the surface and 20 metres seasonal temperatures for the coastal area is maximal in summer, decreases slowly through autumn, rapidly to a winter minimum, and then rises sharply through spring to its summer peak. This cycle is repeated in the same manner in the four-year period, and it may be assumed to be repeated in the same way every year.

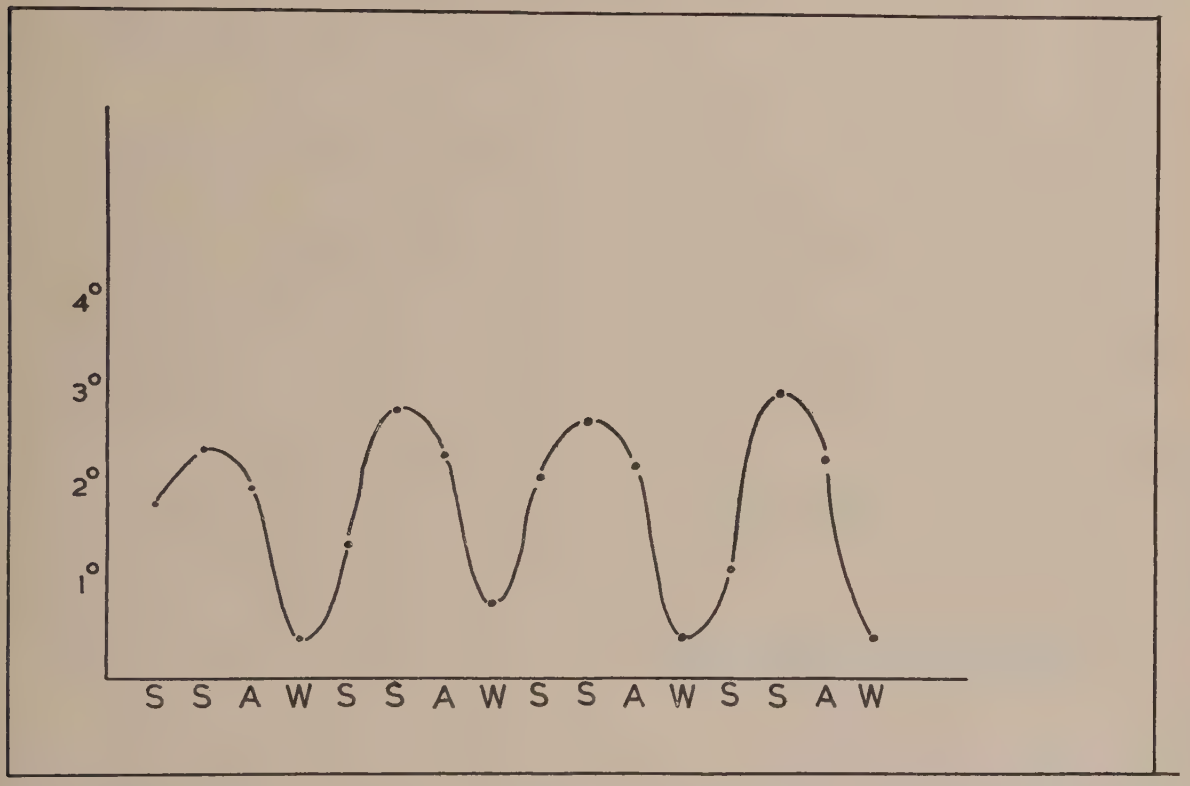

FIG. V.—Seasonal variation of the temperature difference between the surface and 20 metres temperature, Spring, 1950—Winter, 1954.

Similar effects may be obtained by examining individual stations in the coastal area.

(ii) Diurnal Variation of Surface Temperatures.

Table V shows that the surface temperature may vary during a calm day in mid-summer by as much as 2·8°C. This variation would have been greater had strong southerly winds started to blow at, say, noon when instead of surface temperatures of *circa* 17°C, upwelling could have reduced these to *circa* 11°C. This means that during such a time the temperature values in the upper layers in the coastal area would fluctuate considerably, and that a single set of values for any such locality may be quite contrary to what the actual monthly mean would have been had regular daily readings been taken.

The need for more data is therefore essential if a more accurate and representative account of the temperature environment of the pilchard fishing grounds is to be given. The recording of *surface* temperature alone in the immediate proximity of boats in the act of fishing, does not give an accurate indication of the temperature of the depth at which

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the fish shoals are found. If more accurate and representative temperature data could therefore be obtained, correlation with factors such as availability and catch per unit effort for instance could be attempted. Details concerning the depth at which pilchards and maasbankers are caught and temperature records at this depth would be an invaluable aid for correlation of environmental conditions with the occurrence of these fishes.

12. Conclusions.

(*a*) Annual isotherm patterns have been found to be basically alike.

(*b*) From the average of all temperature values taken during the four-year period, 1953/54 appears to have been colder than " average " and 1950/51 slightly warmer than " average ".

(*c*) Over a 12-month period the temperature difference between the surface and 20 metres and between the surface and the 0–50 metres average, from one period to another reduce to almost identical values.

(*d*) The 20 metres temperature is considered to be a better guide to the intrinsic value of the upper layers than the surface value, which latter is often affected by the action of sunlight.

(*e*) An average seasonal change in temperature has been described for the surface, 20 metres and the 0–50 metres layer.

(*f*) Maximal pilchard catches are registered in the seasons characterized by a lack in horizontal temperature gradients, whereas seasons of maximum maasbanker catches coincide with the presence of strong horizontal *and* vertical gradients.

(*g*) Regular seasonal cycles of temperature have been observed in the outer area, with maxima mainly in summer to autumn, and minima in winter to spring.

(*h*) Using the 20 metres temperature as a criterion, the temperature cycle along the coast is an inversion of the cycle found at the outer, deeper stations.

(*i*) The zone in which the most rapid rate of change in temperature with increasing depth takes place, or the thermocline, lies within the upper 50 metres close inshore.

(*j*) An amplitude of 2·8°C in surface temperature has been recorded in a 24-hour period at a fixed position in midsummer.

(*k*) The value represented by the difference in surface and 20 metres temperatures at coastal stations, is found to vary seasonally, being maximal in summer and minimal in winter.

(*l*) It is felt that, owing to the rapidity with which the temperatures change in the upper layers at coastal stations, much more data of a more specific nature are needed. This means that efforts should be made to study these stations at shorter intervals than has yet been possible, and to augment routine work with data related to short-period variations.

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(ii) 23rd Annual Report for year ended December, 1951, Pretoria, 1953.

(iii) 24th Annual Report for the period 1st Jan., 1952–31st March, 1953, Pretoria, 1954.

(iv) 25th Annual Report for the period 1st April, 1953 31st March, 1954, Pretoria, 1955.

(v) 26th Annual Report for the period 1st April, 1954–31st March, 1955, Pretoria, 1956.

Appendix I.

Monthly, Seasonal and Annual Values of Surface Temperature

Year.	Month/Season.	A.	B.	C.	G.	S.	T.	Average Outer Stations.	D.	E.	F.	H.	I.
1950	September.....	15·54	15·47	15·17	15·42	15·57	15·43	15·43	14·94	14·74	15·24	14·78	14·86
1950	October.....	17·56	16·85	17·07	17·25	18·44	18·29	17·58	16·84	16·29	16·85	16·35	16·61
1950	November.....	16·90	17·09	17·35	17·02	17·44	17·61	17·23	15·97	16·56	17·21	14·79	14·07
1950	**Spring.....**	**16·67**	**16·47**	**16·53**	**16·56**	**17·15**	**17·11**	**16·75**	**15·92**	**15·86**	**16·43**	**15·31**	**15·18**
1950	December.....	17·77	17·86	17·58	17·35	17·78	17·99	17·72	16·07	16·10	18·09	16·11	16·39
1951	January.....	17·76	16·03	17·11	15·56	19·16	18·15	17·29	16·91	16·66	16·26	13·61	15·16
1951	February.....	16·80	17·41	18·36	14·89	17·20	16·09	16·79	17·69	16·89	15·89	13·41	14·75
1950/1	**Summer.....**	**17·44**	**17·10**	**17·68**	**15·93**	**18·05**	**17·41**	**17·27**	**16·89**	**16·55**	**16·75**	**14·38**	**15·43**
1951	March.....	17·89	18·39	16·33	15·25	18·63	17·06	17·26	14·45	14·23	15·45	14·88	14·93
1951	April.....	19·63	19·57	18·31	16·05	19·66	19·43	18·78	16·19	15·74	16·41	15·11	16·93
1951	May.....	19·73	19·19	18·27	18·67	20·21	20·09	19·36	17·83	18·05	17·97	16·11	16·64
1951	**Autumn.....**	**19·08**	**19·05**	**17·64**	**16·66**	**19·50**	**18·86**	**18·47**	**16·16**	**16·01**	**16·61**	**15·37**	**16·17**
1951	June.....	18·21	18·27	18·32	16·56	17·98	17·49	17·81	15·75	15·90	15·55	14·18	15·70
1951	August.....	15·18	15·03	14·08	15·13	15·33	15·28	15·01	14·18	14·38	14·98	14·68	14·88
1951	**Winter.....**	**16·69**	**16·65**	**16·20**	**15·85**	**16·65**	**16·39**	**16·41**	**14·97**	**15·14**	**15·27**	**14·43**	**15·13**
1950/1	**Comm. Year.....**	**17·54**	**17·38**	**17·09**	**16·29**	**17·95**	**17·54**	**17·30**	**16·07**	**15·96**	**16·35**	**14·91**	**15·51**
1951	September.....	14·88	15·08	14·73	15·06	14·98	15·13	14·98	13·98	13·98	15·18	15·28	14·28
1951	October.....	15·43	15·43	14·68	14·98	15·28	14·98	15 13	14·68	15·18	15·08	15·58	13·57
1951	November.....	15·63	16·29	15·26	15·78	15·70	16·34	15·83	14·78	14·83	15·88	15·68	14·98
1951	**Spring.....**	**15·31**	**15·60**	**14·89**	**15·27**	**15·32**	**15·48**	**15·31**	**14·48**	**14·66**	**15·38**	**15·51**	**14·28**
1951	December.....	16·89	16·19	16·04	16·19	17·37	17·25	16·65	15·33	17·01	16·41	15·33	15·48
1952	January.....	21·51	20·81	20·91	21·29	19·11	21·46	20·85	18·31	19·51	18·10	20·26	16·69
1952	February.....	18·34	18·35	19·21	18·00	18·83	18·91	18·61	17·34	18·00	18·12	19·31	16·09
1951/2	**Summer.....**	**18·91**	**18·45**	**18·72**	**18·49**	**18·44**	**19·21**	**18·70**	**16·99**	**18·17**	**17·54**	**18·30**	**16·09**
1952	March.....	18·30	19·06	18·60	19·56	20·01	19·61	19·19	17·19	18·02	17·34	16·14	17·24
1952	April.....	17·09	18·30	18·41	19·66	19·56	19·61	18·77	16·25	16·50	15·78	17·52	15·13
1952	May.....	16·68	16·89	16·39	16·68	17·00	15·47	16·52	14·58	14·96	14·39	15·28	14·74
1952	**Autumn.....**	**17·32**	**18·08**	**17·80**	**18·63**	**18·86**	**18·23**	**18·16**	**16·01**	**16·49**	**15·84**	**16·31**	**15·70**
1952	June.....	18·00	17·20	16·29	18·10	18·15	18·27	17·67	16·89	14·45	17·90	16·68	17·80
1952	July.....	16·89	16·64	16·39	15·28	16·74	15·88	16·30	14·98	15·13	14·98	14·18	15·28
1952	August.....	14·88	14·68	14·78	14·98	14·93	15·43	14·95	14·08	15·13	14·68	15·08	14·33
1952	**Winter.....**	**16·59**	**16·17**	**15·82**	**16·12**	**16·61**	**16·53**	**16·31**	**15·32**	**14·90**	**15·85**	**15·31**	**15·80**
1951/2	**Comm. Year.....**	**17·04**	**17·08**	**16·81**	**17·13**	**17·31**	**17·36**	**17·12**	**15·70**	**16·06**	**16·15**	**16·36**	**15·47**

FOR INDIVIDUAL STATIONS AND SUB-AREAS, SEPTEMBER, 1950–AUGUST, 1954.

Year.	Month/Season.	J.	K.	Average Middle Stations.	L.	M.	N.	O.	P.	Q.	R.	Average Coastal Stations.	Average Routine Area.
1950	September.....	14·95	14·69	14·89	13·62	13·56	14·19	14·55	14·40	13·76	14·13	14·03	14·75
1950	October.....	16·71	16·20	16·55	15·66	14·85	15·62	15·79	15·47	14·33	15·42	15·31	16·42
1950	November.....	16·25	14·71	15·65	13·83	12·87	13·40	14·63	12·67	13·05	12·54	13·28	15·30
1950	Spring.....	15·97	15·20	15·70	14·37	13·76	14·40	14·99	14·18	13·71	14·03	14·21	15·49
1950	December.....	15·27	15·78	16·26	14·85	13·43	14·25	15·63	12·27	12·99	14·53	13·99	15·90
1951	January.....	15·31	16·76	15·81	15·83	15·96	14·56	15·06	13·61	14·72	12·45	14·60	15·83
1951	February.....	16·08	15·50	15·74	15·42	12·42	13·69	14·33	13·67	12·51	12·23	13·47	15·26
1950/1	Summer.....	15·55	16·01	15·94	15·37	13·94	14·17	15·01	13·18	13·41	13·07	14·02	15·67
1951	March.....	13·63	13·85	14·49	13·79	13·11	13·65	12·90	12·40	12·25	12·67	12·97	14·79
1951	April.....	14·69	14·65	15·67	14·91	14·43	13·46	13·40	12·94	13·65	13·30	13·73	15·92
1951	May.....	16·51	15·53	16·95	15·95	15·93	15·73	15·31	15·61	15·93	16·55	15·86	17·29
1951	Autumn.....	14·94	14·68	15·70	14·88	14·49	14·28	13·87	13·65	13·94	14·17	14·18	16·00
1951	June.....	15·27	14·23	15·18	13·73	13·67	13·57	13·73	14·01	13·67	14·73	13·87	15·51
1951	August.....	14·48	13·27	14·41	13·27	12·97	13·47	12·87	13·88	12·22	14·37	13·29	14·20
1951	Winter.....	14·87	13·75	14·79	13·50	13·32	13·52	13·30	13·95	12·95	14·55	13·58	14·85
1950/1	Comm. Year.....	15·38	15·01	15·60	14·62	13·93	14·14	14·38	13·72	13·55	13·90	14·04	15·56
1951	September.....	13·68	13·68	14·29	13·27	12·67	13·86	13·88	13·47	13·47	13·98	13·51	14·23
1951	October.....	14·58	15·18	14·84	14·58	13·70	13·37	13·29	13·73	12·67	14·18	13·65	14·51
1951	November.....	14·86	14·03	15·01	12·22	12·42	12·72	15·38	12·92	14·69	13·07	13·35	14·67
1951	Spring.....	14·37	14·30	14·71	13·36	12·93	13·32	14·18	13·37	13·61	13·74	13·50	14·47
1951	December.....	16·49	13·88	15·70	13·05	12·65	11·97	12·22	13·94	11·79	16·44	13·15	15·10
1952	January.....	17·90	15·38	18·02	13·47	11·47	13·47	17·19	12·12	14·48	17·44	14·23	17·54
1952	February.....	16·09	16·68	17·38	17·49	16·69	16·12	16·19	14·78	13·47	17·29	16·00	17·27
1951/2	Summer.....	16·83	15·31	17·03	14·67	13·60	13·85	15·20	13·61	13·25	17·06	14·46	16·63
1952	March.....	17·14	16·64	17·10	15·68	12·02	14·78	15·10	14·68	14·28	16·57	14·73	16·90
1952	April.....	14·87	13·82	15·70	14·48	12·54	14·48	14·28	13·69	13·12	15·48	14·01	16·03
1952	May.....	14·60	13·42	14·57	13·24	12·36	12·89	13·08	12·77	14·32	12·95	13·09	14·63
1952	Autumn.....	15·54	14·63	15·79	14·47	12·31	14·05	14·15	13·71	13·91	15·00	13·94	15·85
1952	June.....	15·18	14·58	16·21	12·37	12·27	12·47	13·02	12·27	13·98	14·48	12·98	15·52
1952	July.....	14·83	13·57	14·71	13·02	12·42	12·27	13·47	12·32	12·27	13·83	12·80	14·52
1952	August.....	13·68	13·47	14·35	13·88	12·97	12·97	12·87	13·02	12·57	14·18	13·21	14·13
1952	Winter.....	14·56	13·87	15·09	13·09	12·55	12·57	13·12	12·54	12·94	14·16	13·00	14·72
1951/2	Comm. Year.....	15·33	14·53	15·66	13·89	12·85	13·45	14·16	13·31	13·43	14·99	13·73	15·42

APPENDIX I—(*Continued*).

MONTHLY, SEASONAL AND ANNUAL VALUES OF SURFACE TEMPERATURE

Year.	Month/Season.	A.	B.	C.	G.	S.	T.	Average Outer Stations.	D.	E.	F.	H.	I.
1952	September.....	15·88	15·38	15·68	15·63	15·42	15·68	15·61	15·08	15·24	15·53	16·49	15·48
1952	October.....	16·21	15·84	15·85	15·80	15·78	15·88	15·89	15·14	15·66	15·78	15·28	15·50
1952	November.....	18·14	17·70	17·94	17·90	17·69	16·89	17·71	17·54	17·13	18·00	17·44	18·00
1952	Spring.....	16·74	16·31	16·49	16·44	16·30	16·15	16·41	15·92	16·01	16·44	16·40	16·33
1952	December.....	18·80	16·59	17·01	17·19	18·74	17·70	17·67	15·88	15·18	14·86	14·39	15·75
1953	January.....	19·03	19·36	19·61	18·48	20·01	20·57	19·51	17·80	17·21	18·78	18·38	18·40
1953	February.....	16·48	16·94	18·30	16·89	16·39	16·72	16·95	13·58	15·09	14·90	15·07	13·60
1952/3	Summer.....	18·10	17·63	18·31	17·52	18·38	18·33	18·04	15·75	15·83	16·18	15·95	15·92
1953	March.....	17·70	18·24	18·32	17·57	16·70	18·20	17·79	17·88	18·50	18·00	16·29	17·49
1953	April.....	16·20	17·41	17·49	15·58	15·68	15·64	16·33	15·03	15·68	15·96	14·38	15·28
1953	May.....	17·49	17·18	16·05	17·70	17·60	17·70	17·29	15·44	16·89	16·29	17·09	15·99
1953	Autumn.....	17·13	17·61	17·29	16·95	16·66	17·18	17·14	16·12	17·02	16·75	15·92	16·25
1953	June.....	14·90	15·03	15·45	15·21	15·94	15·90	15·40	15·03	14·58	14·20	14·45	14·41
1953	July.....	15·57	15·38	15·18	15·52	15·58	15·63	15·48	13·86	15·26	15·39	16·09	14·59
1953	August.....	14·55	14·38	14·29	15·08	14·88	14·83	14·67	13·82	14·02	14·88	14·18	13·62
1953	Winter.....	15·01	14·93	14·97	15·27	15·47	15·45	15·18	14·24	14·62	14·82	14·91	14·21
1952/3	Comm. Year.....	16·75	16·62	16·76	16·55	16·70	16·78	16·69	15·51	15·87	16·05	15·79	15·67
1953	September.....	15·83	16·29	14·98	14·68	15·89	15·65	15·55	14·58	14·58	14·78	14·50	15·71
1953	October.....	15·70	15·88	13·98	16·39	15·99	16·70	15·77	13·99	16·19	16·33	16·29	13·68
1953	November.....	16·18	17·33	16·97	17·48	18·00	18·10	17·34	15·01	16·03	16·20	15·21	14·87
1953	Spring.....	15·90	16·50	15·31	16·18	16·63	16·82	16·22	14·53	15·60	15·77	15·33	14·75
1953	December.....	15·92	14·93	17·42	13·67	16·99	15·45	15·73	15·67	15·47	12·95	12·44	12·96
1954	January.....	18·90	17·50	15·59	16·07	18·61	18·31	17·50	17·19	17·29	14·67	14·15	14·37
1954	February.....	20·62	20·81	20·54	21·32	21·48	21·52	21·05	18·74	17·41	20·61	15·17	18·00
1953/4	Summer.....	18·48	17·75	17·85	17·02	19·03	18·43	18·09	17·20	16·72	16·08	13·92	15·11
1954	March.....	17·79	18·76	18·80	15·47	17·91	18·65	17·90	19·19	18·90	15·37	14·75	16·68
1954	April.....	19·03	18·62	17·18	18·64	19·08	19·14	18·61	15·22	14·87	18·70	14·73	17·08
1954	May.....	17·73	17·73	16·32	17·59	17·69	17·29	17·39	14·91	16·97	14·99	16·07	16·85
1954	Autumn.....	18·18	18·37	17·43	17·23	18·23	18·36	17·97	16·44	16·91	16·35	15·18	16·87
1954	June.....	15·83	15·13	15·82	16·17	16·72	15·98	15·94	14·45	14·85	16·26	15·46	15·86
1954	July.....	15·05	14·77	14·93	14·92	15·03	15·13	14·97	14·61	14·52	14·57	14·72	14·41
1954	August.....	14·47	14·97	14·45	14·89	14·85	15·10	14·79	13·99	13·38	14·20	14·18	14·05
1954	Winter.....	15·12	14·96	15·07	15·33	15·53	15·40	15·23	14·35	14·25	15·01	14·79	14·77
1953/4	Comm. Year.....	16·92	16·89	16·41	16·44	17·35	17·25	16·88	15·63	15·87	15·80	14·81	15·38

FOR INDIVIDUAL STATIONS AND SUB-AREAS, SEPTEMBER, 1950–AUGUST, 1954.

Year.	Month/Season.	J.	K.	Average Middle Stations.	L.	M.	N.	O.	P.	Q.	R.	Average Coastal Stations.	Average Routine Area.
1952	September.....	14·43	14·78	15·29	16·17	15·78	14·54	14·53	14·35	14·48	15·68	15·07	15·31
1952	October.....	15·48	15·63	15·49	15·18	12·97	14·33	14·58	14·88	12·95	15·08	14·28	15·19
1952	November.....	17·32	17·04	17·49	17·36	16·93	17·53	16·93	17·36	14·29	17·49	16·84	17·33
1952	Spring.....	15·74	15·82	16·09	16·24	15·23	15·47	15·35	15·53	13·91	16·08	15·40	15·95
1952	December.....	14·69	14·76	15·07	15·48	15·28	14·65	13·76	14·19	13·07	14·28	14·39	15·61
1953	January.....	17·09	16·26	17·70	16·29	12·78	14·42	14·60	13·02	12·97	16·99	14·44	17·10
1953	February.....	13·65	13·87	14·25	13·47	14·18	13·27	12·97	12·67	11·95	12·73	13·03	14·64
1952/3	Summer.....	15·14	14·96	15·68	15·08	14·08	14·11	13·78	13·29	12·66	14·67	13·95	15·78
1953	March.....	17·80	18·14	17·73	17·83	17·65	14·79	16·79	15·25	14·33	14·86	15·93	17·12
1953	April.....	14·88	14·72	15·13	14·96	14·27	15·08	14·66	14·71	14·68	13·88	14·61	15·31
1953	May.....	14·90	14·57	15·89	14·47	14·28	13·84	13·98	14·07	13·68	15·01	14·19	15·71
1953	Autumn.....	15·86	15·81	16·25	15·75	15·40	14·57	15·14	14·68	14·23	14·58	14·91	16·05
1953	June.....	14·58	14·21	14·49	13·42	12·67	12·47	14·38	13·11	11·77	14·34	13·17	14·30
1953	July.....	13·86	13·98	14·72	12·57	12·17	12·37	14·52	12·77	13·78	13·80	13·14	14·39
1953	August.....	14·11	14·23	14·12	13·07	12·87	12·97	12·93	12·77	12·65	12·37	12·80	13·83
1953	Winter.....	14·18	14·14	14·45	13·02	12·57	12·60	13·94	12·88	12·73	13·50	13·04	14·17
1952/3	Comm. Year.....	15·23	15·18	15·61	15·02	14·32	14·19	14·55	14·09	13·38	14·71	14·32	15·49
1953	September.....	14·40	13·93	14·64	14·08	13·88	14·08	14·38	13·89	14·08	13·78	14·02	14·70
1953	October.....	12·72	11·10	14·33	11·79	10·75	11·86	10·32	11·49	9·83	11·17	11·03	13·61
1953	November.....	16·04	14·68	15·43	13·87	10·53	12·33	13·52	12·72	11·12	12·58	12·38	14·94
1953	Spring.....	14·39	13·24	14·80	13·25	11·72	12·76	12·74	12·70	11·68	12·51	12·48	14·41
1953	December.....	14·67	13·90	14·01	14·77	12·98	11·89	13·77	12·14	13·38	10·63	12·79	14·10
1954	January.....	14·76	14·65	15·30	14·29	12·27	14·07	13·62	13·72	12·17	12·93	13·30	15·26
1954	February.....	18·35	16·60	17·84	14·62	13·91	14·79	15·79	15·27	14·77	14·98	14·88	17·77
1953/4	Summer.....	15·93	15·05	15·72	14·56	13·05	13·58	14·39	13·71	13·44	12·85	13·65	15·71
1954	March.....	16·02	17·08	16·86	17·49	14·80	15·45	16·78	13·37	16·70	12·16	15·25	16·61
1954	April.....	14·81	14·43	15·69	14·37	14·48	12·97	13·29	13·65	13·74	12·79	13·61	15·84
1954	May.....	16·96	15·31	16·01	13·47	14·64	14·23	13·63	14·61	14·37	14·47	14·20	15·79
1954	Autumn.....	15·93	15·61	16·19	15·11	14·64	14·22	14·57	13·88	14·94	13·14	14·36	16·08
1954	June.....	15·15	13·47	15·07	13·41	12·34	13·96	14·89	14·43	14·45	14·35	13·98	14·95
1954	July.....	14·89	14·02	14·53	14·11	12·16	13·12	14·52	12·94	14·42	14·91	13·74	14·39
1954	August.....	14·28	13·97	14·01	14·02	13·58	13·63	13·85	13·30	13·56	14·07	13·72	14·14
1954	Winter.....	14·77	13·82	14·54	13·85	12·69	13·57	14·42	13·56	14·14	14·44	13·81	14·49
1953/4	Comm. Year.....	15·25	14·43	15·31	14·19	13·03	13·53	14·03	13·46	13·55	13·23	13·57	15·17

Appendix II.

Monthly, Seasonal and Annual Values of 20 Metres Temperature

Year.	Month/Season.	A.	B.	C.	G.	S.	T.	Average Outer Stations.	D.	E.	F.	H.	I.
1950	September.....	15·48	15·42	15·09	15·24	15·25	15·22	15·28	14·70	14·64	15·19	14·76	14·69
1950	October.....	17·01	16·37	16·37	16·90	18·11	18·08	17·14	15·97	15·91	16·45	15·79	15·74
1950	November.....	16·24	16·35	16·84	16·01	17·13	17·27	16·64	14·53	13·93	15·65	14·61	13·19
1950	**Spring.....**	**16·24**	**16·05**	**16·10**	**16·05**	**16·83**	**16·86**	**16·35**	**15·07**	**14·83**	**15·76**	**15·05**	**14·54**
1950	December.....	17·25	17·05	17·17	17·15	17·81	17·95	17·40	15·11	15·95	17·29	15·03	14·66
1951	January.....	17·18	15·62	14·94	13·59	17·21	15·25	15·63	14·51	15·57	14·10	13·25	14·49
1951	February.....	15·19	17·19	17·51	14·18	17·04	14·88	16·00	17·39	14·40	15·19	12·64	14·51
1950/1	**Summer.....**	**16·54**	**16·62**	**16·54**	**14·97**	**17·35**	**16·03**	**16·34**	**15·67**	**15·31**	**15·53**	**13·64**	**14·55**
1951	March.....	17·29	17·96	15·91	13·91	18·03	16·77	16·65	13·81	13·42	14·36	14·07	13·65
1951	April.....	19·41	19·15	16·49	14·43	19·54	19·34	18·06	14·79	15·30	14·82	13·41	14·73
1951	May.....	19·54	19·02	18·19	18·57	20·13	20·00	19·24	17·78	17·95	17·76	16·07	16·27
1951	**Autumn.....**	**18·75**	**18·71**	**16·86**	**15·64**	**19·23**	**18·70**	**17·98**	**15·46**	**15·56**	**15·65**	**14·52**	**14·88**
1951	June.....	18·15	18·23	18·22	15·91	17·93	17·45	17·65	15·60	15·80	15·55	14·05	15·60
1951	August.....	15·10	14·91	14·04	15·05	15·29	15·32	14·95	14·05	14·15	14·89	14·50	14·62
1951	**Winter.....**	**16·63**	**16·57**	**16·13**	**15·48**	**16·61**	**16·39**	**16·30**	**14·83**	**14·97**	**15·22**	**14·27**	**15·11**
1950/1	**Comm. Year.....**	**17·08**	**17·02**	**16·43**	**15·54**	**17·59**	**17·05**	**16·79**	**15·29**	**15·18**	**15·57**	**14·38**	**14·74**
1951	September.....	14·69	14·86	14·55	14·95	14·80	15·00	14·81	13·82	13·71	15·10	14·85	14·21
1951	October.....	14·90	15·03	14·68	14·68	15·00	14·85	14·86	14·50	15·03	14·99	14·90	13·11
1951	November.....	15·51	16·15	14·77	15·80	15·68	16·30	15·70	14·62	14·76	15·85	15·60	13·85
1951	**Spring.....**	**15·03**	**15·35**	**14·67**	**15·14**	**15·16**	**15·38**	**15·12**	**14·31**	**14·50**	**15·31**	**15·12**	**13·72**
1951	December.....	16·85	16·02	15·90	16·00	17·15	17·10	16·50	15·02	16·88	16·30	15·02	15·45
1952	January.....	21·12	20·77	20·50	20·91	16·37	21·23	20·15	15·20	18·45	16·21	16·15	12·91
1952	February.....	18·09	17·20	17·90	16·60	18·50	18·78	17·85	15·98	16·18	17·68	17·10	14·73
1951/2	**Summer.....**	**18·69**	**18·00**	**18·10**	**17·84**	**17·34**	**19·04**	**18·17**	**15·40**	**17·17**	**16·73**	**16·09**	**14·36**
1952	March.....	15·61	16·50	14·64	18·80	18·16	17·70	16·90	16·22	13·33	15·10	14·50	13·81
1952	April.....	16·51	18·09	18·40	19·58	19·53	19·62	18·62	13·11	16·18	15·35	14·50	12·90
1952	May.....	16·50	16·71	16·30	16·49	16·96	15·47	16·41	14·49	14·70	13·91	15·07	14·44
1952	**Autumn.....**	**16·21**	**17·10**	**16·45**	**18·29**	**18·22**	**17·60**	**17·31**	**14·61**	**14·74**	**14·79**	**14·69**	**13·72**
1952	June.....	17·90	17·09	16·10	17·80	18·11	18·24	17·54	16·42	14·42	17·88	15·00	17·80
1952	July.....	16·71	16·51	16·29	15·11	16·30	15·68	16·10	14·90	14·76	14·31	14·10	14·70
1952	August.....	14·20	14·65	14·50	14·69	14·68	15·32	14·67	13·82	14·56	13·90	14·89	14·20
1952	**Winter.....**	**16·27**	**16·08**	**15·63**	**15·87**	**16·36**	**16·41**	**16·10**	**15·05**	**14·58**	**15·36**	**14·66**	**15·57**
1951/2	**Comm. Year.....**	**16·55**	**16·63**	**16·21**	**16·78**	**16·77**	**17·11**	**16·68**	**14·84**	**15·25**	**15·55**	**15·14**	**14·34**

FOR INDIVIDUAL STATIONS AND SUB-AREAS, SEPTEMBER, 1950–AUGUST, 1954.

Year.	Month/Season.	J.	K.	Average Middle Stations.	L.	M.	N.	O.	P.	Q.	R.	Average Coastal Stations.	Average Routine Area.
1950	September.....	14·61	14·52	14·73	13·27	12·08	13·12	13·31	13·19	12·96	12·64	12·94	14·27
1950	October.....	15·59	14·93	15·77	14·92	10·50	12·31	15·43	11·19	13·93	14·39	13·24	15·29
1950	November.....	15·46	13·20	14·37	12·09	9·53	11·22	12·06	9·28	11·07	12·05	11·04	13·89
1950	Spring.....	15·22	14·22	14·96	13·43	10·70	12·22	13·60	11·22	12·65	13·03	12·41	14·48
1950	December.....	14·91	14·88	15·40	13·24	11·63	10·58	14·58	8·89	10·90	13·25	11·87	14·76
1951	January.....	13·44	13·83	14·17	13·30	10·39	11·93	13·37	9·32	12·50	11·68	11·78	13·7
1951	February.....	14·44	13·48	14·58	13·97	9·72	9·89	13·21	8·90	10·91	12·09	11·24	13·84
1950/1	Summer.....	14·26	14·06	14·72	13·50	10·58	10·80	13·72	9·04	11·44	12·34	11·63	14·12
1951	March.....	12·94	12·92	13·60	12·16	9·53	11·57	11·87	8·84	11·02	10·70	10·81	13·54
1951	April.....	13·03	12·07	14·02	12·23	12·09	10·48	11·87	9·17	11·15	11·37	11·19	14·24
1951	May.....	16·45	13·25	16·50	13·79	15·39	15·43	15·25	13·89	11·69	16·51	14·56	16·65
1951	Autumn.....	14·14	12·75	14·71	12·73	12·34	12·49	13·00	10·63	11·29	12·86	12·19	14·81
1951	June.....	15·11	13·93	15·09	13·67	13·68	13·49	13·53	13·89	13·47	14·59	13·76	15·39
1951	August.....	14·37	13·12	14·24	13·07	12·14	11·92	12·71	12·29	12·07	14·02	12·60	13·88
1951	Winter.....	14·74	13·53	14·67	13·37	12·91	12·71	13·12	13·09	12·77	14·31	13·18	14·67
1950/1	Comm. Year.....	14·58	13·65	14·77	13·25	11·52	11·99	13·38	10·80	11·97	13·03	12·28	14·50
1951	September.....	13·17	13·27	14·02	12·72	11·51	13·20	13·42	12·61	12·79	13·00	12·75	13·81
1951	October.....	14·23	14·70	14·49	13·10	12·62	12·98	13·20	11·67	12·40	13·30	12·75	13·99
1951	November.....	14·47	13·92	14·72	11·27	9·19	10·69	11·69	9·49	11·20	11·59	10·73	13·62
1951	Spring.....	13·96	13·96	14·41	12·36	11·11	12·29	12·77	11·26	12·13	12·63	12·08	13·81
1951	December.....	16·20	13·42	15·47	12·65	9·44	10·41	11·79	9·05	11·59	16·10	11·58	14·42
1952	January.....	16·78	14·84	15·79	11·92	10·41	12·38	15·17	9·06	13·90	11·59	12·06	15·79
1952	February.....	13·84	12·99	15·50	11·70	10·89	9·74	12·39	9·74	11·67	12·84	11·28	14·73
1951/2	Summer.....	15·61	13·75	15·59	12·09	10·25	10·84	13·12	9·28	12·39	13·51	11·64	14·98
1952	March.....	13·85	16·11	14·70	11·55	9·74	10·81	13·60	10·09	11·23	11·72	11·25	14·15
1952	April.....	12·79	13·73	14·08	14·15	10·02	9·62	12·51	9·74	11·50	11·57	11·30	14·47
1952	May.....	14·50	12·90	14·29	11·66	10·99	12·69	12·51	10·94	13·85	12·48	12·16	14·18
1952	Autumn.....	13·71	14·25	14·36	12·45	10·25	11·04	12·87	10·26	12·19	11·92	11·57	14·27
1952	June.....	15·20	14·27	15·86	12·32	12·03	12·41	12·43	11·43	12·90	13·96	12·50	15·19
1952	July.....	14·67	12·95	14·34	11·40	10·19	10·83	12·20	11·74	11·19	13·60	11·59	13·91
1952	August.....	13·79	11·99	13·88	12·64	12·67	12·09	12·20	12·67	12·19	13·55	12·57	13·66
1952	Winter.....	14·55	13·07	14·69	12·12	11·63	11·78	12·28	11·95	12·09	13·70	12·22	14·25
1951/2	Comm. Year.....	14·46	13·76	14·76	12·26	10·81	11·49	12·76	10·69	12·20	12·94	11·88	14·33

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APPENDIX II—(*continued*).

MONTHLY, SEASONAL AND ANNUAL VALUES OF 20 METRES TEMPERATURE

Year.	Month/Season.	A.	B.	C.	G.	S.	T.	Average Outer Stations.	D.	E.	F.	H.	I.
1952	September.....	15·76	15·32	15·61	15·40	15·20	15·61	15·48	15·10	15·16	15·30	15·42	15·24
1952	October.....	15·74	15·50	15·81	15·80	15·74	15·85	15·74	15·00	15·30	15·15	15·09	15·20
1952	November.....	18·01	17·68	17·82	15·13	17·50	16·40	17·09	16·48	16·40	16·91	15·88	16·85
1952	**Spring.....**	**16·50**	**16·17**	**16·41**	**15·44**	**16·15**	**15·95**	**16·10**	**15·53**	**15·62**	**15·79**	**15·46**	**15·76**
1952	December.....	18·68	15·40	15·72	14·63	18·40	17·37	16·70	15·70	14·42	13·50	12·38	15·42
1953	January.....	18·60	18·38	18·12	18·06	14·94	20·27	18·06	16·80	15·42	17·33	16·51	17·20
1953	February.....	16·20	16·50	18·10	16·61	16·28	16·63	16·72	13·49	14·62	14·31	14·41	12·36
1952/3	**Summer.....**	**17·83**	**16·76**	**17·31**	**16·43**	**16·54**	**18·09**	**17·16**	**15·33**	**14·82**	**15·05**	**14·43**	**14·99**
1953	March.....	16·65	18·08	17·79	14·85	15·50	16·20	16·51	16·38	16·01	16·30	12·47	16·37
1953	April.....	15·64	16·33	17·35	14·80	15·22	14·80	15·69	14·20	15·46	15·49	13·32	14·76
1953	May.....	17·40	17·01	15·86	17·70	17·40	17·45	17·14	14·97	16·00	14·45	16·83	15·88
1953	**Autumn.....**	**16·56**	**17·14**	**17·00**	**15·78**	**16·04**	**16·15**	**16·45**	**15·18**	**15·82**	**15·41**	**14·21**	**15·67**
1953	June.....	14·85	15·00	15·38	15·13	15·92	15·86	15·36	15·01	14·51	14·01	14·21	14·31
1953	July.....	15·50	15·32	15·06	15·27	15·39	15·25	15·30	13·57	15·22	15·32	15·95	14·17
1953	August.....	14·51	14·35	14·29	14·81	14·61	14·54	14·52	13·80	13·95	14·87	13·91	13·57
1953	**Winter.....**	**14·95**	**14·89**	**14·91**	**15·07**	**15·31**	**15·22**	**15·06**	**14·13**	**14·56**	**14·73**	**14·69**	**14·02**
1952/3	**Comm. Year.....**	**16·46**	**16·24**	**16·41**	**15·68**	**16·00**	**16·35**	**16·19**	**15·04**	**15·21**	**15·25**	**14·70**	**15·11**
1953	September.....	15·67	16·09	14·07	14·22	15·43	15·18	15·11	14·14	13·97	14·47	14·17	15·24
1953	October.....	15·61	15·67	13·37	15·97	15·57	16·26	15·41	13·17	16·11	16·20	15·77	13·49
1953	November.....	15·47	17·20	16·58	17·18	17·62	17·79	16·97	14·27	15·28	15·14	14·87	13·81
1953	**Spring.....**	**15·58**	**16·32**	**14·67**	**15·79**	**16·21**	**16·41**	**15·83**	**13·86**	**15·12**	**15·27**	**14·94**	**14·18**
1953	December.....	15·55	14·17	16·95	13·39	16·71	15·07	15·31	15·07	15·12	12·37	12·08	12·20
1954	January.....	16·90	16·69	15·51	14·55	18·10	16·25	16·33	15·07	15·67	14·67	13·52	14·30
1954	February.....	18·05	16·60	15·63	20·02	20·42	20·84	18·59	14·78	13·28	17·47	11·72	15·13
1953/4	**Summer.....**	**16·83**	**15·82**	**16·03**	**15·99**	**18·41**	**17·39**	**16·74**	**14·97**	**14·69**	**14·84**	**12·44**	**13·88**
1954	March.....	15·65	17·61	16·70	14·57	16·80	16·38	16·29	16·93	14·87	14·07	13·61	13·47
1954	April.....	19·03	17·61	14·73	18·64	19·08	19·14	18·04	15·22	14·13	18·30	13·12	13·72
1954	May.....	17·73	17·73	14·53	17·46	17·69	17·20	17·05	14·71	16·30	14·71	15·35	16·46
1954	**Autumn.....**	**17·47**	**17·65**	**15·32**	**16·89**	**17·86**	**17·57**	**17·13**	**15·62**	**15·10**	**15·69**	**14·03**	**14·55**
1954	June.....	15·83	15·13	15·66	16·17	16·70	15·98	15·91	14·35	14·85	16·26	15·46	15·82
1954	July.....	15·05	14·77	14·89	14·97	15·03	15·13	14·97	14·52	14·47	14·61	14·75	14·39
1954	August.....	14·45	14·95	14·30	14·38	14·48	14·51	14·51	13·78	13·90	14·22	14·18	14·04
1954	**Winter.....**	**15·11**	**14·95**	**14·95**	**15·17**	**15·40**	**15·21**	**15·13**	**14·22**	**14·41**	**15·03**	**14·80**	**14·75**
1953/4	**Comm. Year.**	**16·25**	**16·19**	**15·24**	**15·96**	**16·97**	**16·64**	**16·21**	**14·67**	**14·83**	**15·21**	**14·05**	**14·34**

FOR INDIVIDUAL STATIONS AND SUB-AREAS, SEPTEMBER, 1950–AUGUST, 1954.

Year.	Month/Season.	J.	K.	Average Middle Stations.	L.	M.	N.	O.	P.	Q.	R.	Average Coastal Stations.	Average Routine Area.
1952	September.....	14·78	14·22	15·03	14·62	13·90	13·56	14·56	12·84	14·20	14·82	14·07	14·83
1952	October.....	15·14	15·02	15·13	13·43	9·60	10·83	14·02	10·65	12·83	14·75	12·30	14·32
1952	November.....	15·61	13·70	15·98	15·59	13·30	10·97	16·27	10·89	12·25	15·18	13·49	15·44
1952	Spring.....	15·18	14·31	15·38	14·55	12·27	11·79	14·95	11·46	13·09	14·92	13·29	14·87
1952	December.....	14·28	12·25	13·99	14·21	11·26	11·51	13·75	9·29	11·73	11·67	11·92	14·08
1953	January.....	16·18	14·99	16·35	10·31	9·69	12·07	12·45	9·12	9·88	14·29	11·12	15·03
1953	February.....	13·50	12·68	13·62	11·72	9·69	9·78	11·00	9·99	10·71	12·18	10·72	13·54
1952/3	Summer.....	14·65	13·31	14·65	12·08	10·21	11·12	12·40	9·47	10·77	12·71	11·25	14·21
1953	March.....	17·24	13·76	15·50	12·91	10·18	10·79	14·25	9·39	13·60	11·39	11·79	14·51
1953	April.....	14·22	13·82	14·47	12·84	12·92	13·94	13·52	13·03	14·41	11·77	13·20	14·39
1953	May.....	14·75	14·40	15·33	13·88	13·85	11·30	13·75	12·14	10·92	14·88	12·96	15·04
1953	Autumn.....	15·40	13·99	15·10	13·21	12·32	12·01	13·84	11·52	12·98	12·68	12·65	14·65
1953	June	14·43	13·88	14·34	12·91	11·56	12·10	14·19	11·30	11·00	14·21	12·47	13·99
1953	July	13·48	13·81	14·50	12·13	11·40	11·55	14·11	12·71	13·37	13·73	12·71	14·12
1953	August.....	14·09	14·11	14·04	12·48	12·52	12·93	12·91	12·62	12·61	12·27	12·62	13·69
1953	Winter.....	14·00	13·93	14·29	12·51	11·83	12·19	13·74	12·21	12·33	13·40	12·60	13·93
1952/3	Comm. Year.....	14·81	13·89	14·86	13·09	11·66	11·78	13·73	11·16	12·29	13·43	12·45	14·41
1953	September.....	13·32	11·99	13·90	12·77	12·40	12·67	13·77	12·88	12·42	13·57	12·93	13·92
1953	October.....	12·57	10·98	14·04	11·08	9·77	10·70	10·18	10·18	9·60	10·96	10·35	13·16
1953	November.....	15·42	12·90	14·53	11·65	8·83	11·27	12·11	8·49	10·31	12·45	10·73	13·93
1953	Spring.....	13·77	11·96	14·16	11·83	10·33	11·55	12·02	10·52	10·78	12·33	11·34	13·67
1953	December.....	13·87	12·47	13·31	12·31	9·58	9·48	12·77	8·79	12·49	10·31	10·82	13·02
1954	January.....	14·35	13·88	14·49	10·45	9·09	8·90	13·09	8·79	12·10	10·91	10·48	13·64
1954	February.....	14·72	13·47	14·37	13·47	9·48	9·56	11·08	9·48	10·59	10·88	10·65	14·33
1953/4	Summer.....	14·31	13·27	14·06	12·08	9·38	9·31	12·31	9·02	11·73	10·70	10·65	13·67
1954	March.....	13·15	14·41	14·36	11·39	9·60	9·29	11·06	9·12	10·36	10·76	10·23	13·49
1954	April.....	14·50	11·71	14·39	11·48	13·91	11·87	13·01	12·28	9·54	11·87	11·99	14·64
1954	May.....	16·72	15·11	15·62	12·20	14·43	14·11	13·33	14·11	14·09	14·97	13·89	15·45
1954	Autumn.....	14·79	13·74	14·79	11·69	12·65	11·76	12·47	11·84	11·33	12·53	12·04	14·53
1954	June.....	15·09	13·44	15·04	13·37	12·08	13·90	14·21	12·76	12·60	14·35	13·32	14·70
1954	July.....	14·91	14·03	14·53	13·83	12·00	12·69	14·57	13·03	14·37	14·91	13·63	14·35
1954	August.....	14·28	13·97	14·05	14·02	13·46	13·46	13·60	12·66	13·49	13·81	13·50	14·00
1954	Winter.....	14·76	13·81	14·54	13·74	12·51	13·35	14·13	12·82	13·49	14·36	13·48	14·35
1953/4	Comm. Year.....	14·41	13·20	14·39	12·33	11·21	11·49	12·73	11·05	11·83	12·48	11·87	14·05

Appendix III.

Monthly, Seasonal and Annual Values of 0–50 Metres Mean Integral Temperature

Year.	Month/Season.	A.	B.	C.	G.	S.	T.	Average Outer Stations.	D.	E.	F.	H.	I.
1950	September.....	15·38	15·27	15·06	15·12	15·37	15·33	15·25	14·49	14·49	15·09	14·65	14·54
1950	October.....	16·85	16·17	16·22	16·55	17·63	17·58	16·83	15·75	15·58	16·11	15·41	15·46
1950	November.....	16·10	16·43	16·63	16·05	17·01	17·16	16·56	14·41	13·83	15·51	14·26	12·93
1950	**Spring.....**	**16·11**	**15·96**	**15·97**	**15·91**	**16·67**	**16·69**	**16·22**	**14·88**	**14·63**	**15·57**	**14·77**	**14·31**
1950	December.....	16·65	16·33	16·67	16·62	16·77	17·61	16·77	14·88	15·01	16·32	14·47	14·09
1951	January.....	16·72	15·32	15·00	13·55	17·22	15·68	15·58	14·08	14·97	14·15	12·82	14·34
1951	February.....	14·75	16·72	16·91	13·67	16·39	14·53	15·49	17·14	14·28	14·50	12·53	13·73
1950/1	**Summer.....**	**16·04**	**16·12**	**16·19**	**14·61**	**16·79**	**15·94**	**15·95**	**15·37**	**14·75**	**14·99**	**13·27**	**14·05**
1951	March.....	17·15	17·93	15·23	13·50	17·79	16·09	16·28	13·49	13·11	14·31	13·61	13·43
1951	April.....	19·32	19·14	16·29	13·89	19·42	19·22	17·88	14·26	14·58	14·64	13·04	14·59
1951	May.....	19·40	18·98	17·68	17·88	19·88	19·85	18·95	17·10	17·09	17·69	15·12	14·71
1951	**Autumn.....**	**18·62**	**18·68**	**16·40**	**15·09**	**19·03**	**18·39**	**17·70**	**14·95**	**14·93**	**15·55**	**13·92**	**14·24**
1951	June.....	17·70	17·70	18·19	15·34	17·89	17·41	17·37	15·23	15·03	15·04	13·62	15·11
1951	August.....	15·11	14·89	14·04	15·02	15·28	15·30	14·94	13·99	14·17	14·87	14·51	14·60
1951	**Winter.....**	**16·41**	**16·29**	**16·11**	**15·18**	**16·59**	**16·35**	**16·15**	**14·61**	**14·60**	**14·95**	**14·07**	**14·85**
1950/1	**Comm. Year.....**	**16·83**	**16·81**	**16·17**	**15·20**	**17·33**	**16·89**	**16·54**	**14·98**	**14·74**	**15·29**	**14·00**	**14·32**
1951	September.....	14·70	14·86	14·57	14·96	14·82	15·00	14·82	13·67	13·63	15·07	14·91	14·17
1951	October.....	14·92	15·10	14·59	14·74	14·99	14·82	14·86	14·22	15·00	14·86	14·86	12·78
1951	November.....	15·49	16·02	14·81	15·78	15·67	16·17	15·66	14·61	14·67	15·77	15·54	13·93
1951	**Spring.....**	**15·04**	**15·33**	**14·66**	**15·16**	**15·16**	**15·33**	**15·11**	**14·17**	**14·43**	**15·23**	**15·10**	**13·63**
1951	December.....	16·85	16·03	15·67	15·74	17·15	17·10	16·42	15·01	16·82	16·27	14·36	15·35
1952	January.....	20·79	20·26	20·25	19·11	16·31	20·43	19·53	14·27	16·86	15·65	15·91	13·60
1952	February.....	17·20	16·11	16·86	16·13	17·19	17·60	16·85	16·18	15·86	16·79	16·08	14·44
1951/2	**Summer.....**	**18·28**	**17·47**	**17·59**	**16·99**	**16·88**	**18·38**	**17·60**	**15·15**	**16·51**	**16·24**	**15·45**	**14·46**
1952	March.....	15·28	16·53	15·02	16·81	17·47	16·75	16·31	14·87	13·95	13·76	13·79	13·17
1952	April.....	15·62	16·20	17·04	18·87	19·53	19·35	17·77	13·28	14·86	14·18	14·30	12·49
1952	May.....	16·19	15·85	16·26	16·19	16·86	15·20	16·09	14·18	13·82	13·87	14·94	13·50
1952	**Autumn.....**	**15·70**	**16·19**	**16·11**	**17·29**	**17·95**	**17·10**	**16·72**	**14·11**	**14·21**	**13·94**	**14·34**	**13·05**
1952	June.....	17·26	16·93	16·08	16·96	17·68	18·13	17·17	15·27	13·77	17·03	14·12	16·77
1952	July.....	16·50	16·48	16·21	14·88	16·18	15·50	15·96	14·54	14·70	13·93	13·73	14·61
1952	August.....	14·24	14·58	14·48	14·66	14·41	15·29	14·61	13·73	14·23	13·94	14·69	14·09
1952	**Winter.....**	**16·00**	**16·00**	**15·59**	**15·50**	**16·09**	**16·31**	**15·91**	**14·51**	**14·23**	**14·97**	**14·18**	**15·16**
1951/2	**Comm. Year.....**	**16·25**	**16·25**	**15·99**	**16·23**	**16·52**	**16·78**	**16·34**	**14·49**	**14·85**	**15·09**	**14·77**	**14·07**

FOR INDIVIDUAL STATIONS AND SUB-AREAS, SEPTEMBER, 1950–AUGUST, 1954.

Year.	Month/Season.	J.	K.	Average Middle Stations.	L.	M.	N.	O.	P.	Q.	R.	Average Coastal Stations.	Average Routine Area.
1950	September.....	14·58	14·29	14·59	12·47	12·16	12·11	13·08	—	12·31	12·29	12·40	14·11
1950	October.....	15·43	14·03	15·40	13·71	11·28	11·99	14·37	—	12·67	13·48	12·92	15·07
1950	November.....	14·57	13·15	14·09	11·45	10·09	11·11	12·25	—	10·54	11·37	11·13	13·94
1950	Spring.....	14·86	13·82	14·69	12·54	11·18	11·74	13·23	—	11·84	12·38	12·15	14·37
1950	December.....	14·33	13·90	14·71	12·37	10·95	10·77	13·66	—	10·61	12·65	11·83	14·45
1951	January.....	13·27	13·25	13·84	12·72	11·45	11·17	12·58	—	11·55	11·15	11·77	13·74
1951	February.....	14·23	12·90	14·19	12·61	10·13	10·52	12·13	—	10·63	11·51	11·25	13·67
1950/1	Summer.....	13·94	13·35	14·25	12·57	10·84	10·82	12·79	—	10·93	11·77	11·62	13·95
1951	March.....	12·45	12·45	13·26	11·39	10·25	11·19	11·59	—	10·79	10·53	10·96	13·49
1951	April.....	13·27	12·14	13·79	11·75	11·26	10·69	11·56	—	10·94	11·15	11·23	14·27
1951	May.....	16·45	12·73	15·84	12·41	13·05	12·46	15·19	—	11·74	15·99	13·47	16·07
1951	Autumn.....	14·06	12·44	14·30	11·85	11·52	11·45	12·78	—	11·16	12·56	11·88	14·61
1951	June.....	14·52	12·98	14·50	13·07	13·64	13·48	12·89	—	12·66	13·41	13·19	14·99
1951	August.....	14·18	13·08	14·20	12·22	11·83	11·29	11·80	—	11·30	13·43	11·98	13·73
1951	Winter.....	14·35	13·03	14·35	12·65	12·73	12·39	12·35	—	11·98	13·42	12·59	14·36
1950/1	Comm. Year.....	14·30	13·17	14·40	12·38	11·46	11·53	12·83	—	11·43	12·45	12·01	14·32
1951	September.....	13·19	13·13	13·97	12·28	11·40	12·71	13·29	—	11·93	12·75	12·39	13·74
1951	October.....	13·92	14·71	14·33	12·49	11·97	12·06	12·21	—	10·95	12·58	12·04	13·77
1951	November.....	14·12	13·82	14·64	10·76	9·53	10·37	11·52	—	11·16	10·97	10·72	13·72
1951	Spring.....	13·74	13·89	14·31	11·84	10·97	11·71	12·34	—	11·35	12·10	11·72	13·74
1951	December.....	16·01	12·98	15·26	11·50	9·80	9·96	11·03	—	10·77	14·63	11·28	14·37
1952	January.....	15·66	13·95	15·13	11·78	10·13	11·13	14·30	—	12·86	12·42	12·10	15·56
1952	February.....	13·59	13·20	15·16	12·06	11·86	11·08	12·30	—	11·47	12·20	11·83	14·64
1951/2	Summer.....	15·09	13·38	15·18	11·78	10·60	10·72	12·54	—	11·70	13·08	11·74	14·86
1952	March.....	13·63	14·26	13·92	12·01	9·92	11·37	13·16	—	11·70	11·89	11·67	13·97
1952	April.....	12·70	12·73	13·51	11·95	10·59	11·00	11·91	—	11·06	12·16	11·45	14·20
1952	May.....	13·75	12·10	13·74	11·47	10·81	11·62	12·44	—	12·63	12·38	11·89	13·90
1952	Autumn.....	13·36	13·03	13·72	11·81	10·44	11·33	12·50	—	11·80	12·14	11·67	14·02
1952	June.....	14·95	13·57	15·07	11·84	11·37	11·63	11·95	—	12·13	13·89	12·13	14·81
1952	July.....	14·41	12·59	14·07	10·99	10·52	10·55	11·83	—	11·27	13·13	11·38	13·82
1952	August.....	13·51	11·86	13·72	11·92	12·53	12·18	12·33	—	12·04	13·47	12·41	13·59
1952	Winter.....	14·29	12·67	14·29	11·58	11·47	11·45	12·05	—	11·81	13·50	11·98	14·07
1951/2	Comm. Year.....	14·12	13·24	14·30	11·75	10·87	11·31	12·35	—	11·66	12·71	11·77	14·21

APPENDIX III—(*continued*).

MONTHLY, SEASONAL AND ANNUAL VALUES OF 0–50 METRES MEAN INTEGRAL TEMPERATURE

Year.	Month/Season.	A.	B.	C.	G.	S.	T.	Average Outer Stations.	D.	E.	F.	H.	I.
1952	September.....	15·66	15·30	15·58	15·33	15·13	15·46	15·41	15·08	15·05	15·00	15·45	14·65
1952	October.....	15·62	15·41	15·74	15·67	15·73	15·71	15·65	14·97	15·34	15·29	15·09	15·10
1952	November.....	17·44	17·58	17·41	15·75	16·66	15·87	16·79	15·24	15·22	16·08	15·88	16·26
1952	**Spring.....**	**16·24**	**16·10**	**16·24**	**15·58**	**15·84**	**15·68**	**15·95**	**15·10**	**15·20**	**15·46**	**15·47**	**15·34**
1952	December.....	16·97	14·75	14·75	14·61	16·99	16·42	15·75	14·16	13·82	13·28	12·34	14·43
1953	January.....	17·45	16·82	17·37	16·55	15·54	18·52	17·04	15·41	15·11	15·66	15·73	15·37
1953	February.....	16·25	15·68	18·00	16·11	16·05	15·97	16·34	13·38	14·51	13·96	13·91	12·54
1952/3	**Summer.....**	**16·89**	**15·75**	**16·71**	**15·76**	**16·19**	**16·97**	**16·38**	**14·32**	**14·48**	**14·30**	**13·99**	**14·11**
1953	March.....	16·43	16·77	16·64	15·04	15·42	16·00	16·05	15·32	15·06	15·65	12·73	15·25
1953	April.....	15·64	15·07	16·74	14·24	15·14	14·36	15·20	14·02	15·36	15·43	12·86	14·14
1953	May.....	17·01	16·86	15·46	17·37	17·28	17·45	16·90	14·64	15·82	13·91	16·06	15·04
1953	**Autumn.....**	**16·36**	**16·23**	**16·28**	**15·55**	**15·95**	**15·94**	**16·05**	**14·66**	**15·41**	**15·00**	**13·88**	**14·81**
1953	June.....	14·86	14·99	15·38	15·08	15·92	15·83	15·34	15·01	14·62	13·73	13·49	13·24
1953	July.....	15·51	15·37	15·06	15·29	15·38	15·28	15·31	13·32	15·21	15·31	15·86	13·76
1953	August.....	14·51	14·35	14·28	14·75	14·65	14·58	14·52	13·65	13·64	14·77	13·88	13·31
1953	**Winter.....**	**14·96**	**14·90**	**14·91**	**15·04**	**15·32**	**15·23**	**15·06**	**13·99**	**14·49**	**14·60**	**14·41**	**13·44**
1952/3	**Comm. Year.....**	**16·11**	**15·75**	**16·03**	**15·48**	**15·82**	**15·95**	**15·86**	**14·52**	**14·90**	**14·84**	**14·44**	**14·42**
1953	September.....	15·64	16·09	14·15	14·22	15·45	15·03	15·10	14·12	14·04	14·40	14·16	14·89
1953	October.....	15·60	15·49	13·45	16·04	15·65	16·31	15·42	13·20	16·10	16·03	15·45	13·26
1953	November.....	15·43	16·50	16·49	16·73	17·47	17·77	16·73	14·09	14·66	14·66	14·08	13·48
1953	**Spring.....**	**15·56**	**16·03**	**14·70**	**15·66**	**16·19**	**16·37**	**15·75**	**13·80**	**14·93**	**15·03**	**14·56**	**13·88**
1953	December.....	15·55	14·21	16·70	13·37	16·67	15·07	15·26	14·48	14·55	12·35	12·13	12·05
1954	January.....	17·17	16·53	15·22	14·25	17·96	16·50	16·27	14·49	15·44	14·20	12·95	13·19
1954	February.....	17·08	17·31	15·98	18·44	18·36	19·47	17·77	14·54	13·20	16·47	12·10	14·85
1953/4	**Summer.....**	**16·60**	**16·02**	**15·97**	**15·35**	**17·66**	**17·01**	**16·43**	**14·50**	**14·40**	**14·34**	**12·39**	**13·36**
1954	March.....	15·09	16·67	16·13	14·22	16·57	16·54	15·87	15·56	14·91	13·31	13·19	13·69
1954	April.....	18·92	16·63	14·93	17·04	18·91	19·01	17·57	14·80	13·65	16·23	12·93	13·64
1954	May.....	17·62	17·51	14·34	16·62	17·47	15·55	16·52	14·61	15·55	13·57	14·47	14·94
1954	**Autumn.....**	**17·21**	**16·94**	**15·13**	**15·96**	**17·65**	**17·03**	**16·65**	**14·99**	**14·70**	**14·37**	**13·53**	**14·09**
1954	June.....	15·83	15·03	15·43	16·04	16·66	15·98	15·83	14·12	14·85	16·25	15·37	15·26
1954	July.....	15·03	14·77	14·87	14·94	15·03	15·13	14·96	14·44	14·46	14·60	14·77	14·39
1954	August.....	14·45	14·94	14·25	14·42	14·53	14·56	14·53	13·96	13·77	14·22	14·16	14·04
1954	**Winter.....**	**15·10**	**14·91**	**14·85**	**15·13**	**15·41**	**15·22**	**15·10**	**14·17**	**14·36**	**15·02**	**14·77**	**14·56**
1953/4	**Comm. Year.....**	**16·12**	**15·97**	**15·16**	**15·53**	**16·73**	**16·41**	**15·99**	**14·37**	**14·60**	**14·69**	**13·81**	**13·97**

FOR INDIVIDUAL STATIONS AND SUB-AREAS, SEPTEMBER, 1950–AUGUST, 1954.

Year.	Month/Season.	J.	K.	Average Middle Stations.	L.	M.	N.	O.	P.	Q.	R.	Average Coastal Stations.	Average Routine Area.
1952	September.....	14·36	13·39	14·71	14·41	13·15	13·07	13·79	—	13·62	14·59	13·77	14·63
1952	October.....	15·15	15·03	15·14	12·94	10·21	11·15	13·30	—	11·91	14·56	12·35	14·42
1952	November.....	15·29	13·60	15·37	13·52	12·86	11·95	14·67	—	11·45	14·08	13·09	15·09
1952	Spring.....	14·93	14·01	15·07	13·62	12·07	12·06	13·92	—	12·33	14·41	13·07	14·71
1952	December.....	13·46	12·05	13·36	12·14	11·33	11·00	12·83	—	11·04	11·38	11·62	13·57
1953	January.....	15·12	14·18	15·23	11·09	10·04	10·92	12·47	—	10·14	13·72	11·40	14·59
1953	February.....	12·60	12·59	13·36	11·08	10·33	10·09	10·93	—	10·21	11·87	10·75	13·48
1952/3	Summer.....	13·73	12·94	13·98	11·44	10·57	10·67	12·08	—	10·46	12·32	11·26	13·88
1953	March.....	14·87	13·32	14·60	12·90	11·49	11·19	12·97	—	12·31	11·16	12·00	14·24
1953	April.....	13·68	13·40	14·13	12·56	12·28	13·49	12·66	—	14·17	11·67	12·81	14·05
1953	May.....	13·97	13·34	14·68	12·50	12·50	11·32	12·52	—	11·04	13·63	12·25	14·62
1953	Autumn.....	14·17	13·35	14·47	12·65	12·09	12·00	12·72	—	12·51	12·15	12·35	14·30
1953	June.....	13·84	13·47	13·91	11·71	11·33	11·48	13·13	—	10·79	12·66	11·85	13·71
1953	July.....	12·98	13·61	14·29	11·67	11·27	11·17	13·45	—	13·15	13·26	12·33	13·99
1953	August.....	14·08	14·03	13·91	12·26	12·53	12·71	12·43	—	12·48	12·17	12·43	13·63
1953	Winter.....	13·63	13·70	14·04	11·88	11·71	11·79	13·00	—	12·14	12·70	12·20	13·78
1952/3	Comm. Year....	14·12	13·50	14·39	12·40	11·61	11·63	12·93	—	11·86	12·89	12·22	14·17
1953	September.....	13·31	12·05	13·85	11·71	11·89	11·85	13·45	—	12·58	13·10	12·43	13·80
1953	October.....	12·36	10·91	13·90	10·38	9·48	10·07	10·19	—	9·52	10·98	10·10	13·18
1953	November.....	14·83	12·88	14·10	10·61	9·14	10·38	11·84	—	10·16	11·93	10·68	13·85
1953	Spring.....	13·50	11·95	13·95	10·90	10·17	10·77	11·83	—	10·75	12·00	10·07	13·61
1953	December.....	13·32	12·40	13·04	11·83	9·87	9·45	11·78	—	12·05	10·35	10·89	13·06
1954	January.....	13·55	12·94	13·82	11·05	9·53	9·74	11·49	—	11·04	10·96	10·64	13·59
1954	February.....	14·17	13·07	14·06	12·13	9·87	10·59	11·14	—	10·37	11·17	10·88	14·23
1953/4	Summer.....	13·68	12·80	13·64	11·67	9·76	9·93	11·47	—	11·15	10·83	10·80	13·63
1954	March.....	13·11	13·77	13·93	11·89	10·21	10·17	12·03	—	11·31	10·72	11·05	13·64
1954	April.....	13·82	11·53	13·80	11·32	12·53	11·10	12·17	—	10·29	11·60	11·50	14·27
1954	May.....	15·59	13·23	14·57	11·30	14·07	14·05	12·50	—	14·06	14·31	13·38	14·81
1954	Autumn.....	14·17	12·84	14·10	11·50	12·27	11·77	12·23	—	11·89	12·21	11·98	14·23
1954	June.....	14·95	12·98	14·83	13·18	11·46	13·35	13·65	—	12·33	14·16	13·02	14·57
1954	July.....	14·91	14·03	14·51	13·24	11·67	12·69	14·44	—	14·23	14·89	13·53	14·34
1954	August.....	14·23	13·97	14·05	13·45	13·11	12·38	12·97	—	13·49	13·72	13·19	13·93
1954	Winter.....	14·70	13·66	14·46	13·29	12·08	12·81	13·69	—	13·35	14·26	13·25	14·28
1953/4	Comm. Year.....	14·01	12·81	14·04	11·84	11·07	11·32	12·30	—	11·79	12·32	11·77	13·94

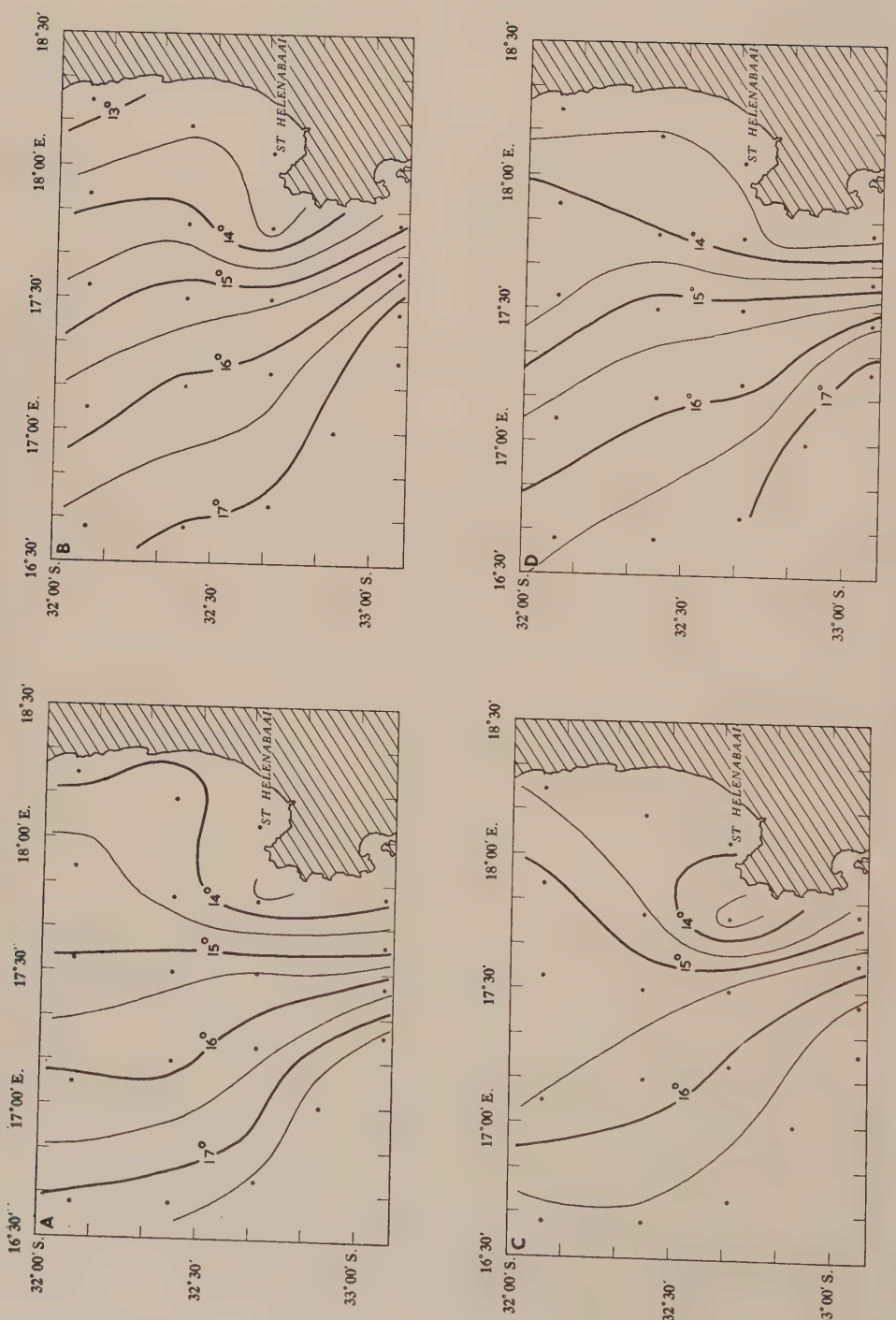

PLATE 1. Average surface temperatures for the year September–August: (A) 1950/51, (B) 1951/52, (C) 1952/53, (D) 1953/54.

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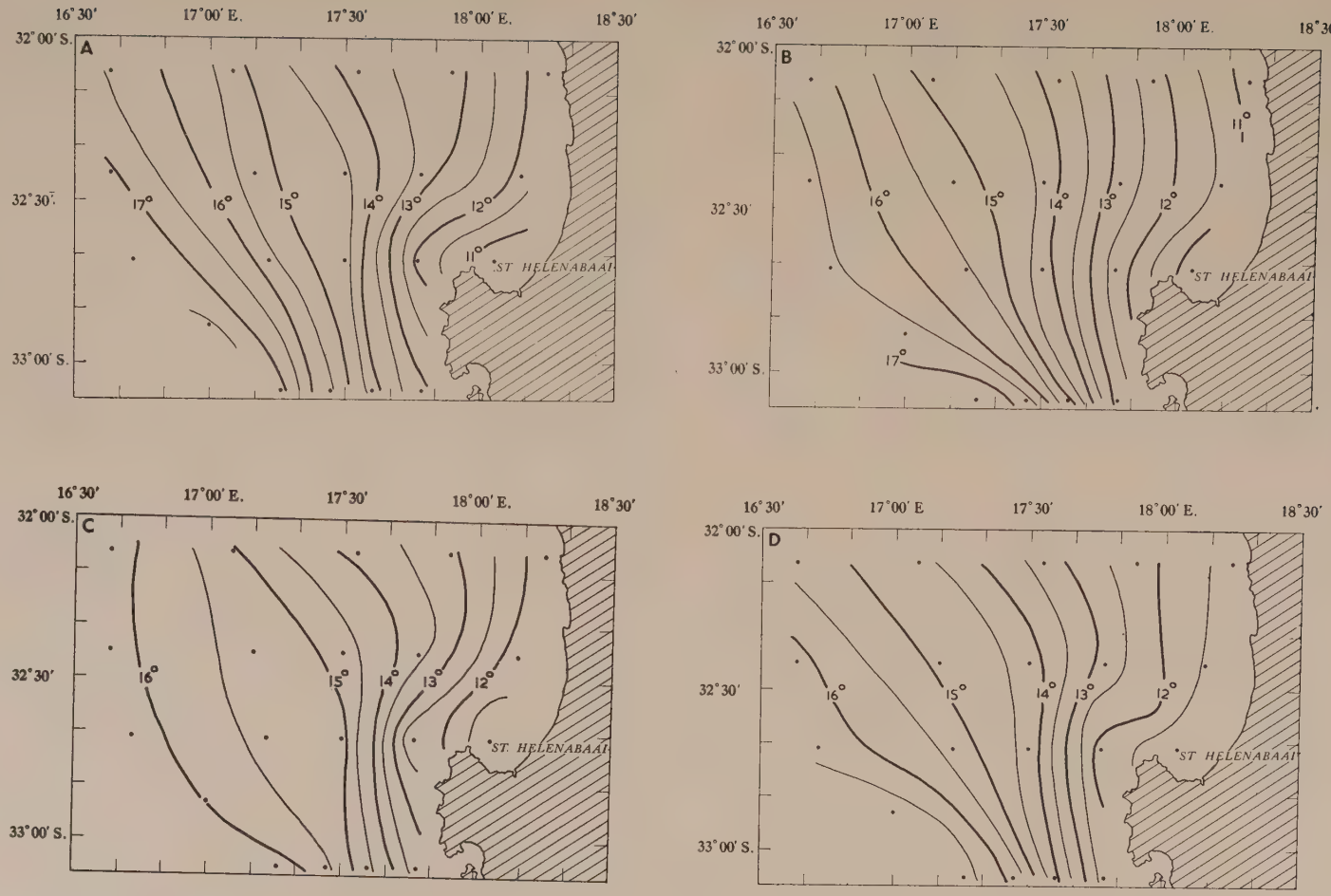

PLATE 2.—Average 20 metres temperatures for the year September–August: (A) 1950/51, (B) 1951/52, (C) 1952/53, (D) 1953/54.

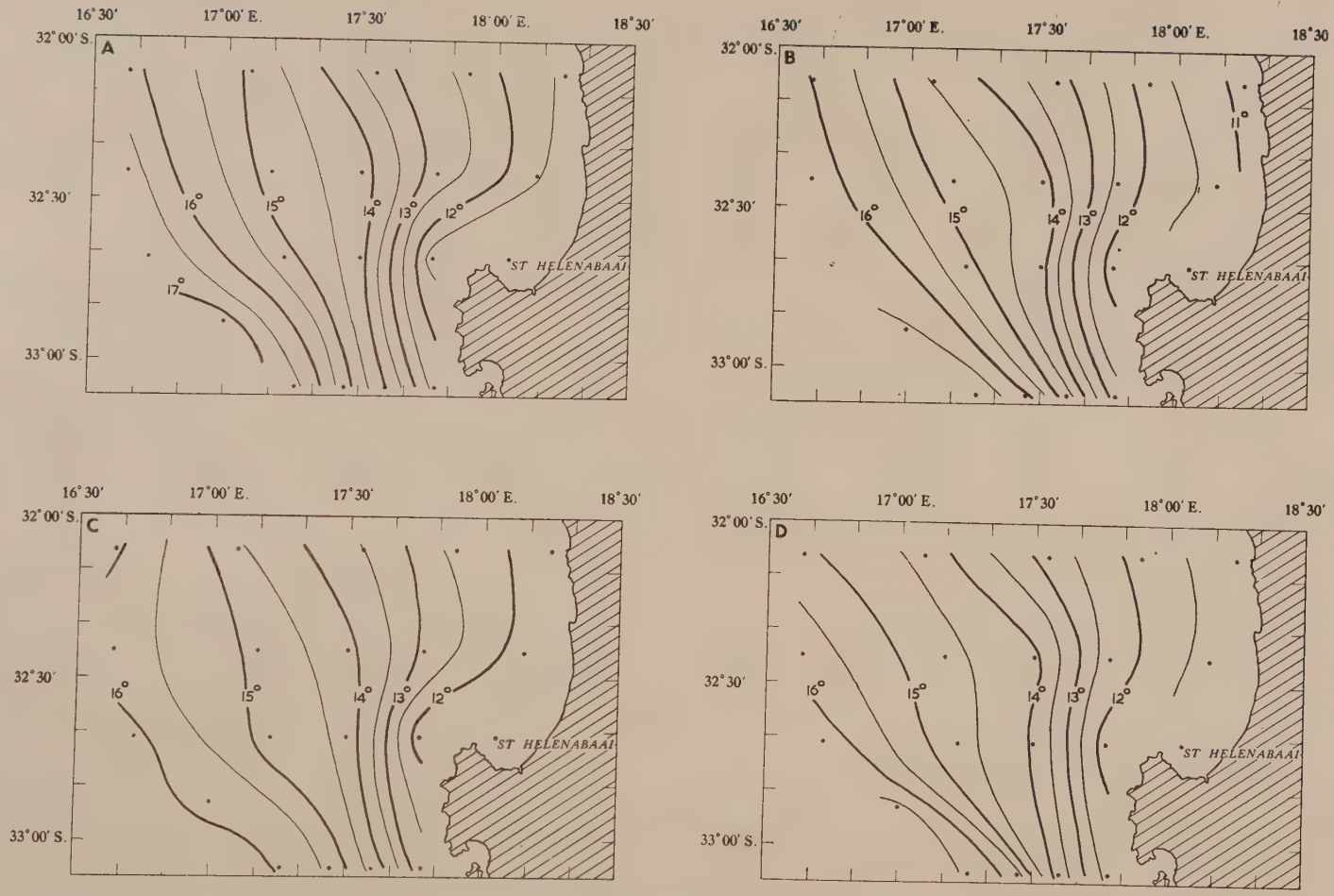

PLATE 3.—Average 0–50 metres mean integral temperatures for the year September–August: (A) 1950/51, (B) 1951/52, (C) 1952/53, (D) 1953/54.

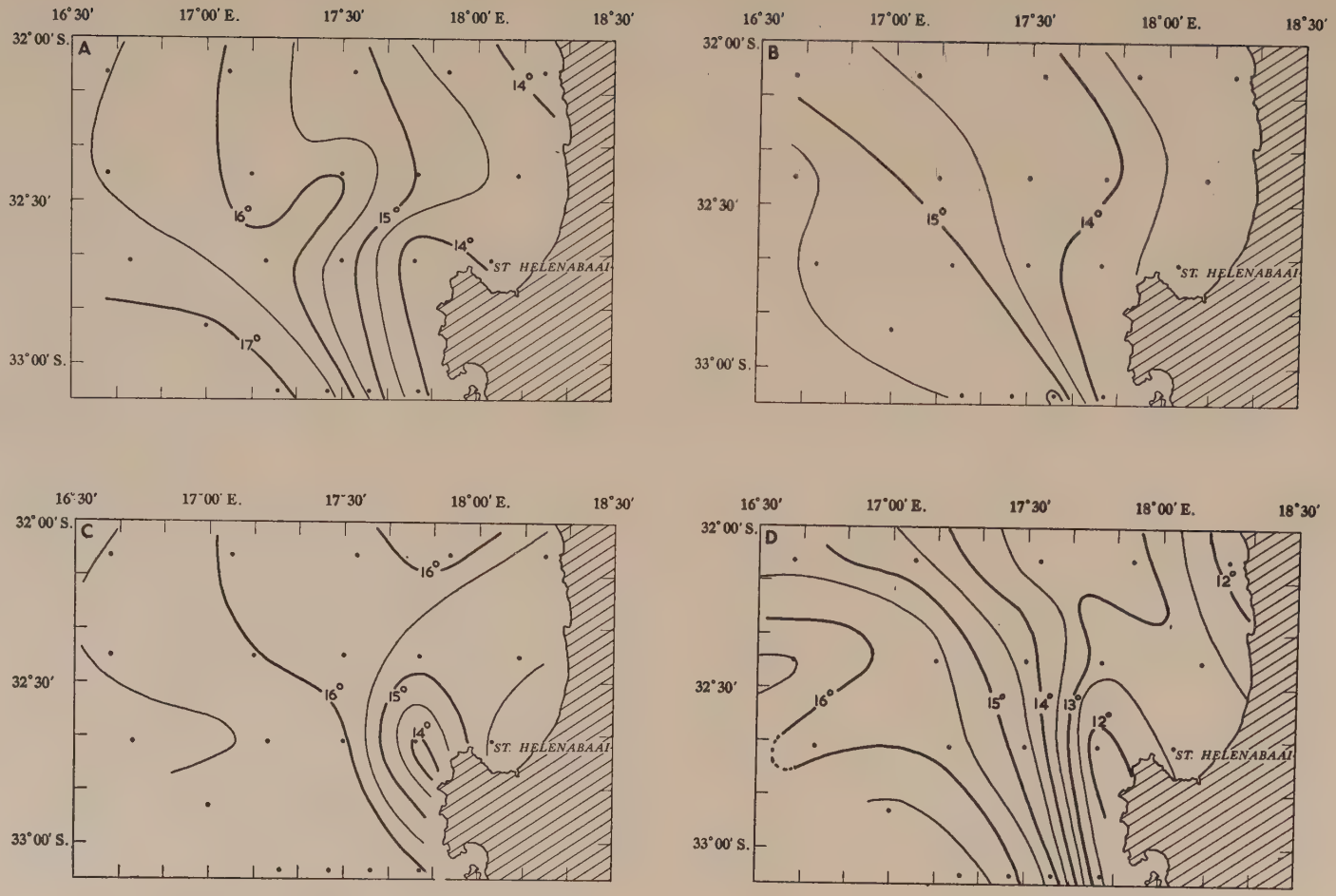

PLATE 4.—Surface temperatures for spring: (A) 1950, (B) 1951, (C) 1952, (D) 1953.

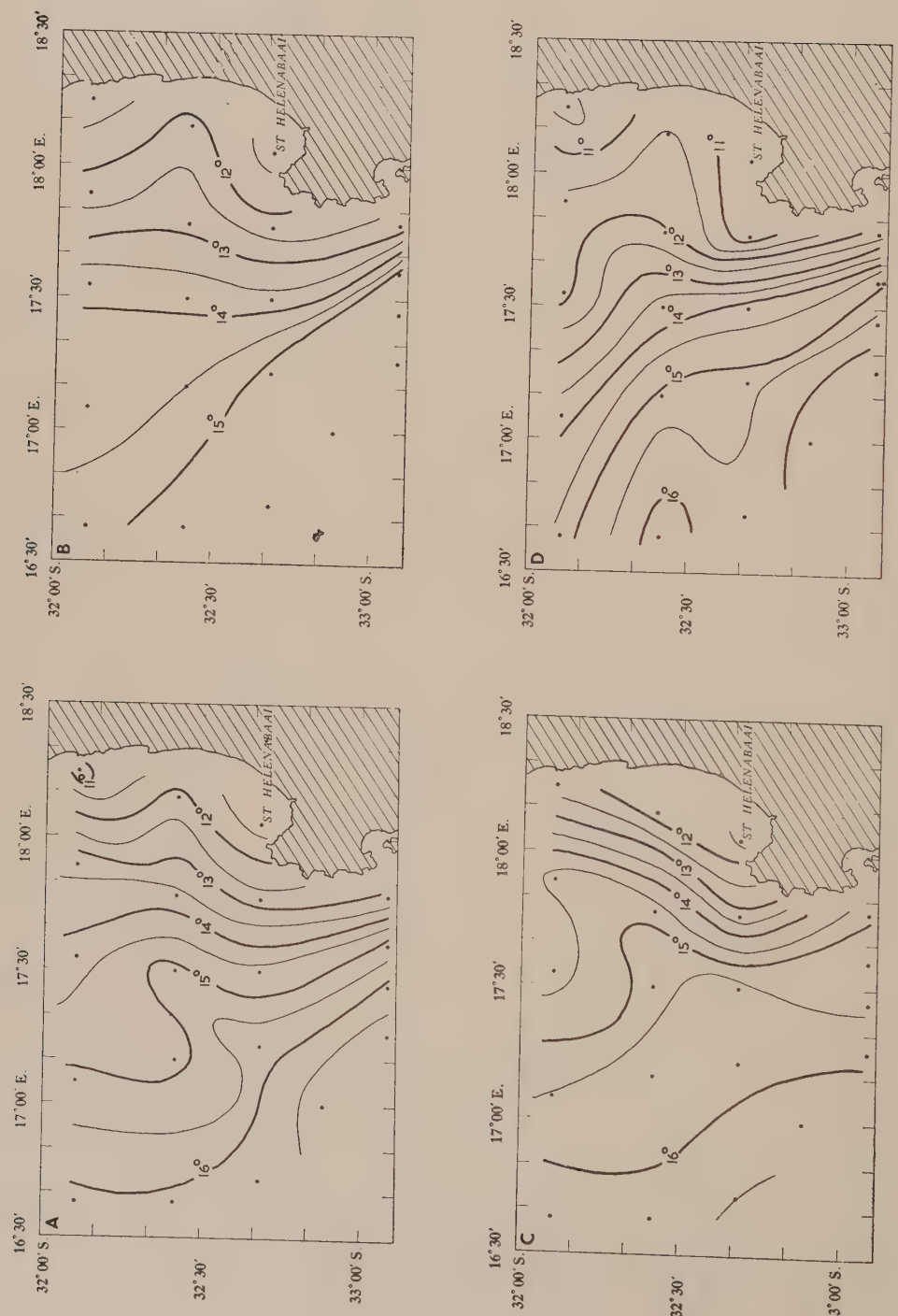

PLATE 5.—20 metres temperatures for spring: (A) 1950, (B) 1951, (C) 1952, (D) 1953.

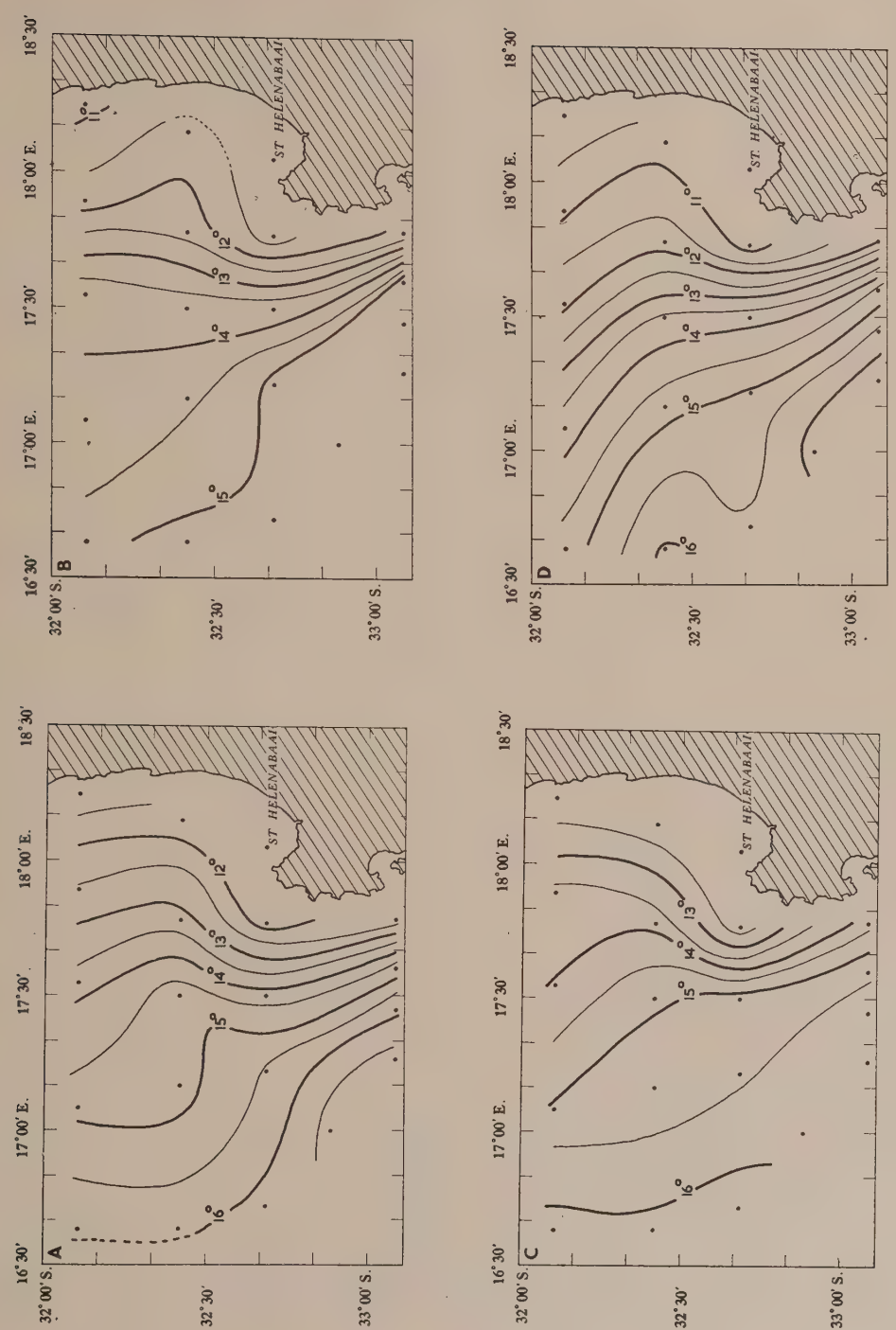

PLATE 6.—0–50 metres mean integral temperatures for spring: (A) 1950, (B) 1951, (C) 1952, (D) 1953.

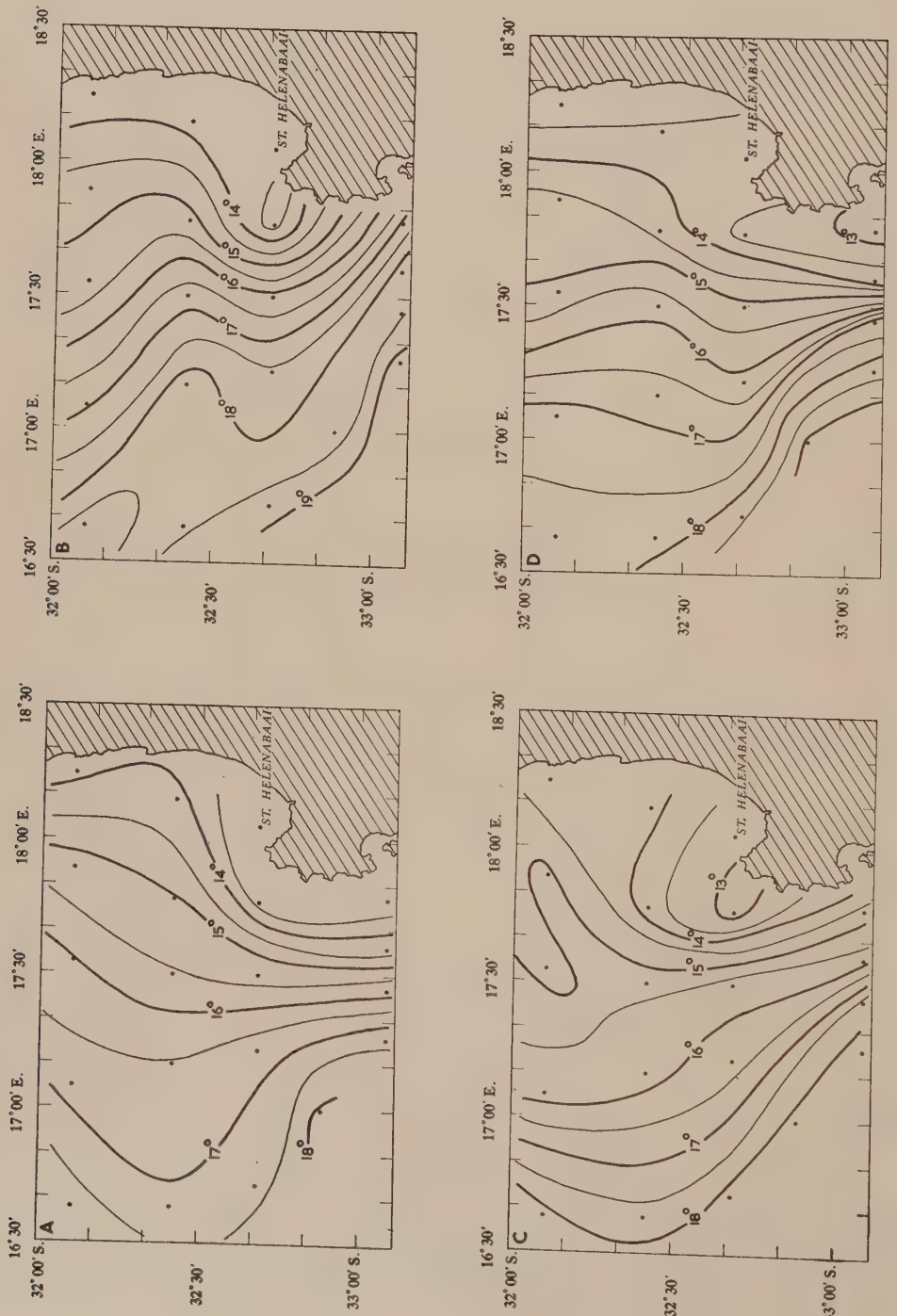

PLATE 7.—Surface temperatures for summer: (A) 1950/51, (B) 1951/52, (C) 1952/53, (D) 1953/54.

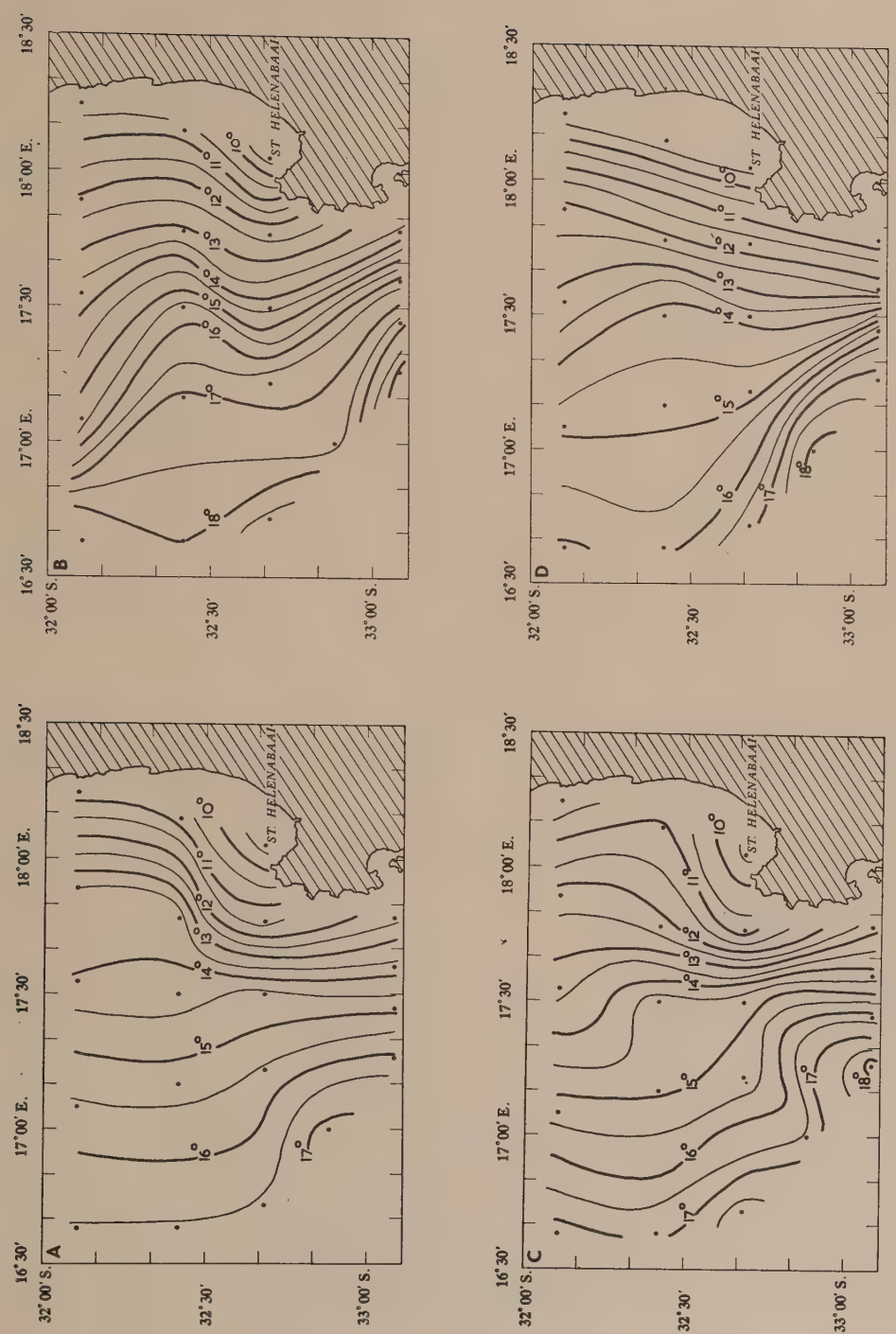

PLATE 8.—20 metres temperatures for summer: (A) 1950/51, (B) 1951/52, (C) 1952/53, (D) 1953/54

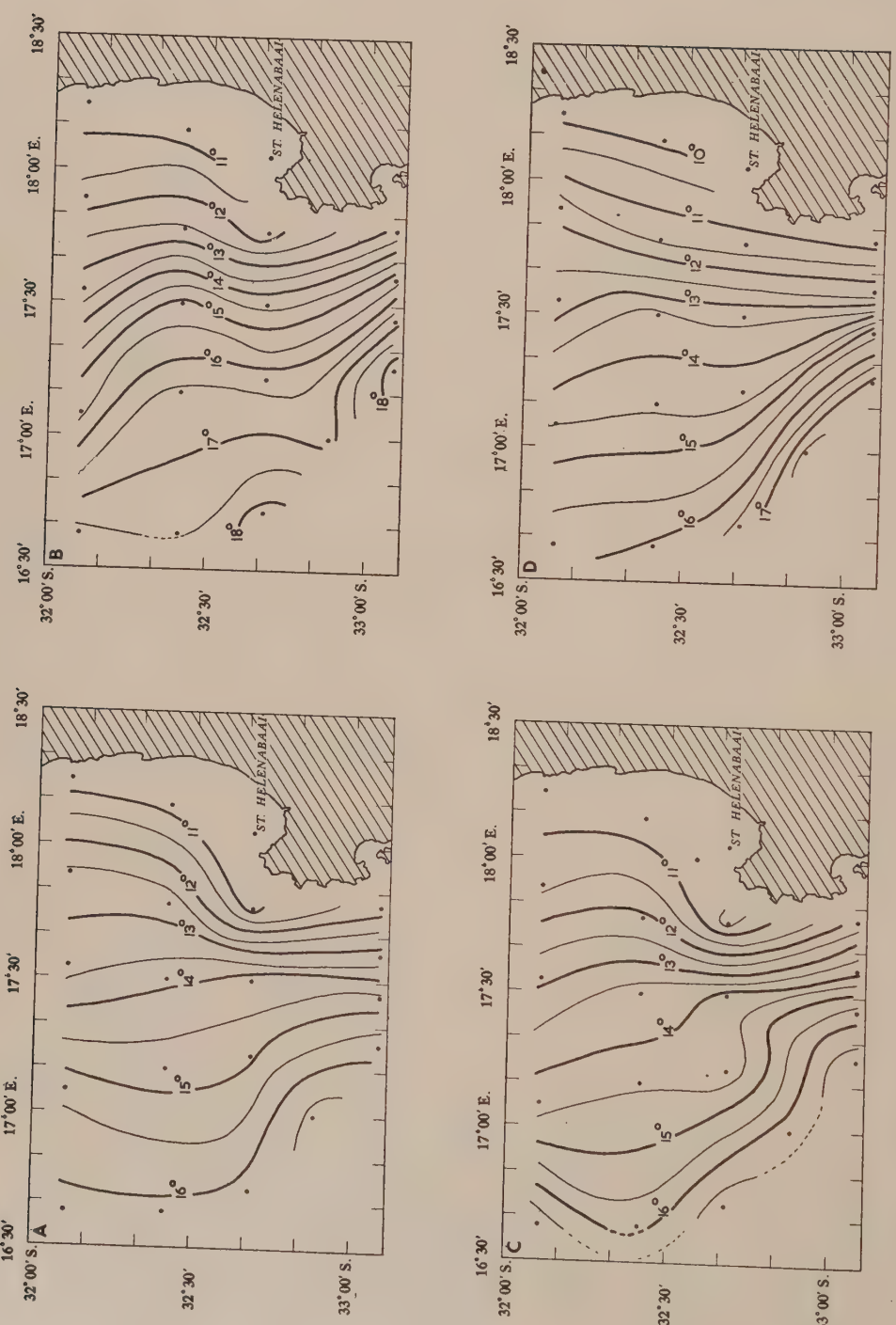

PLATE 9.—0–50 metres mean integral temperatures for summer: (A) 1950/51, (B) 1951/52, (C) 1952/53, (D) 1953/54.

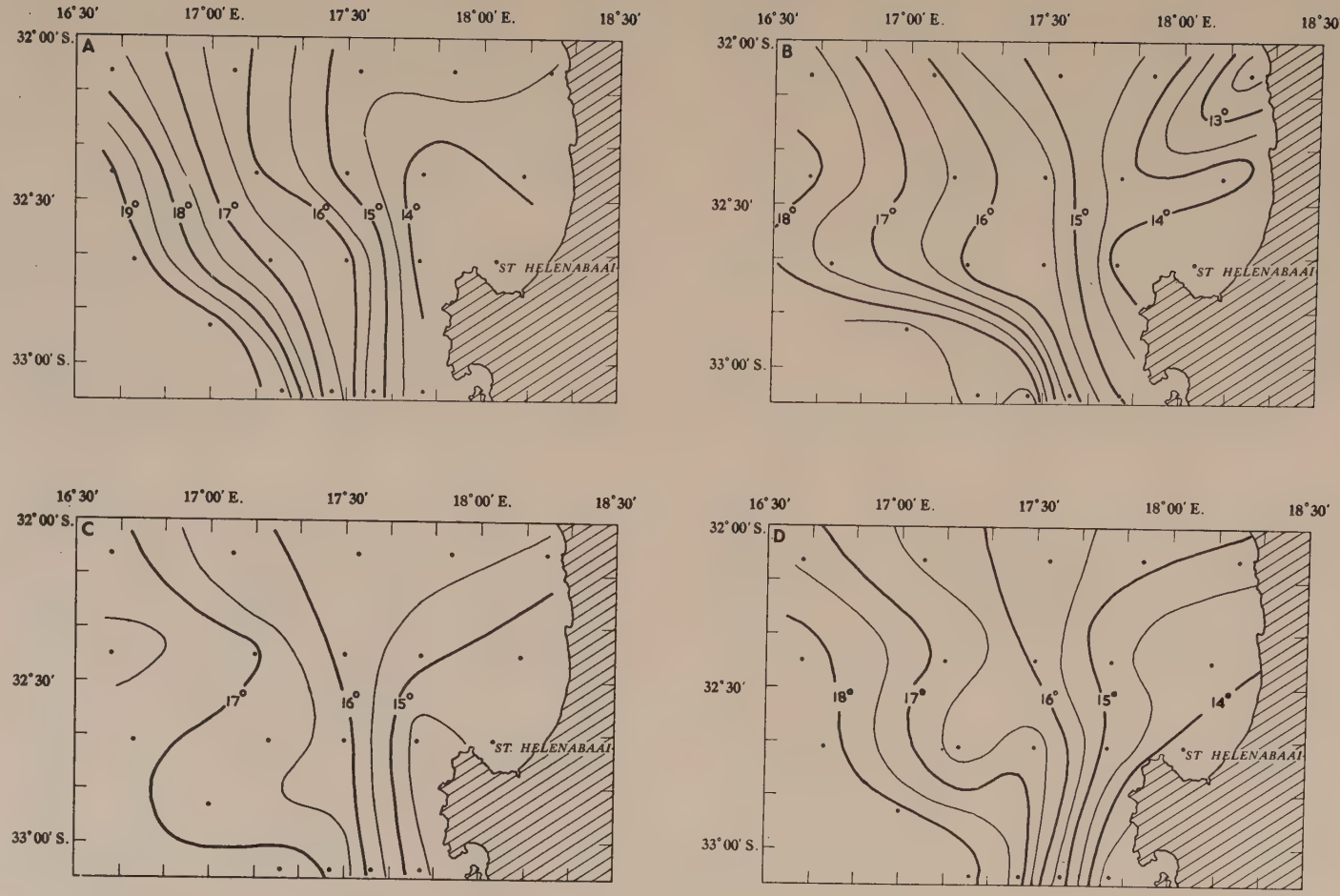

PLATE 10.—Surface temperatures for autumn: (A) 1951, (B) 1952, (C) 1953, (D) 1954.

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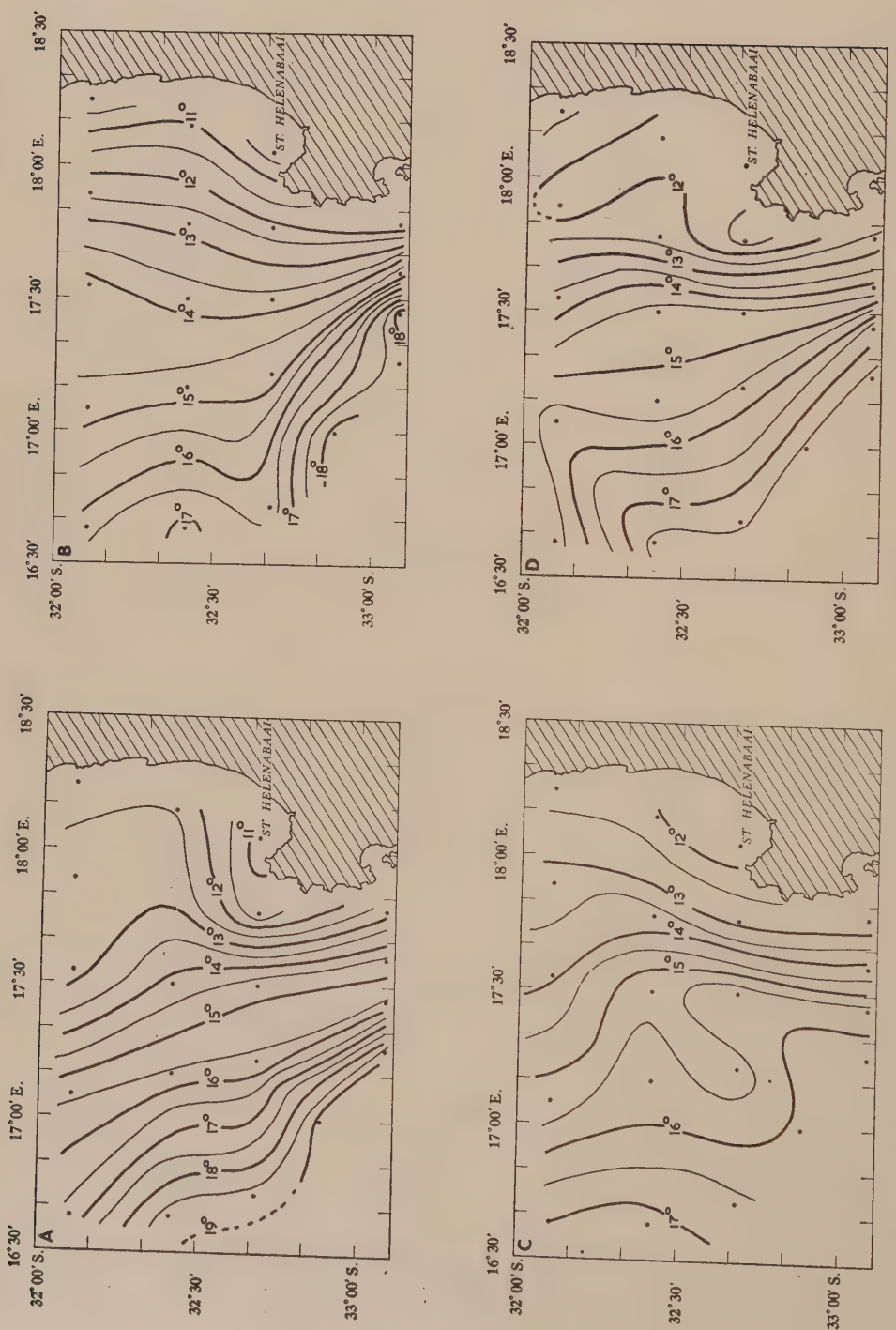

PLATE 11.—20 metres temperatures for autumn: (A) 1951, (B) 1952, (C) 1953, (D) 1954.

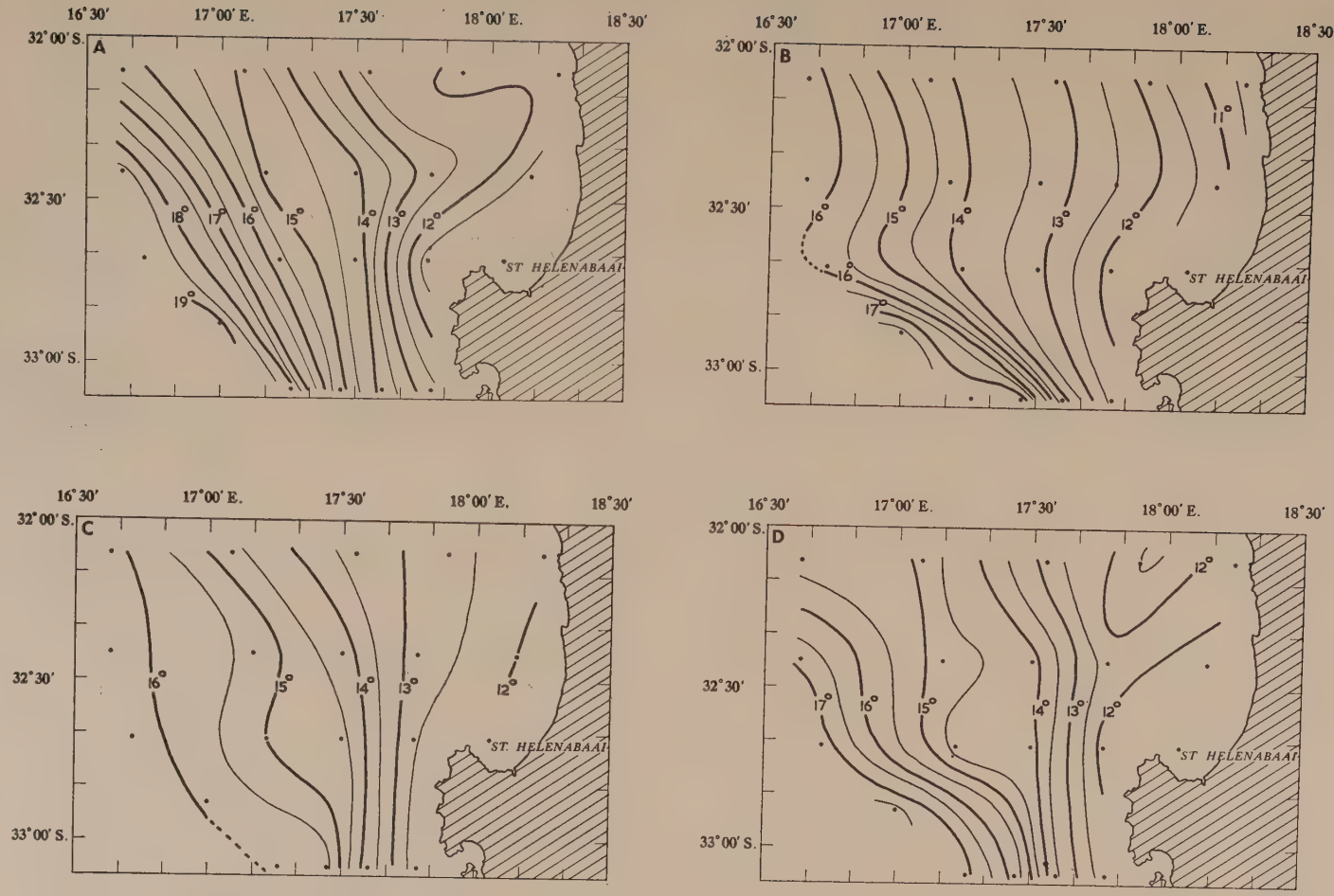

PLATE 12.—0–50 metres mean integral temperatures for autumn: (A) 1951, (B) 1952, (C) 1953, (D) 1954.

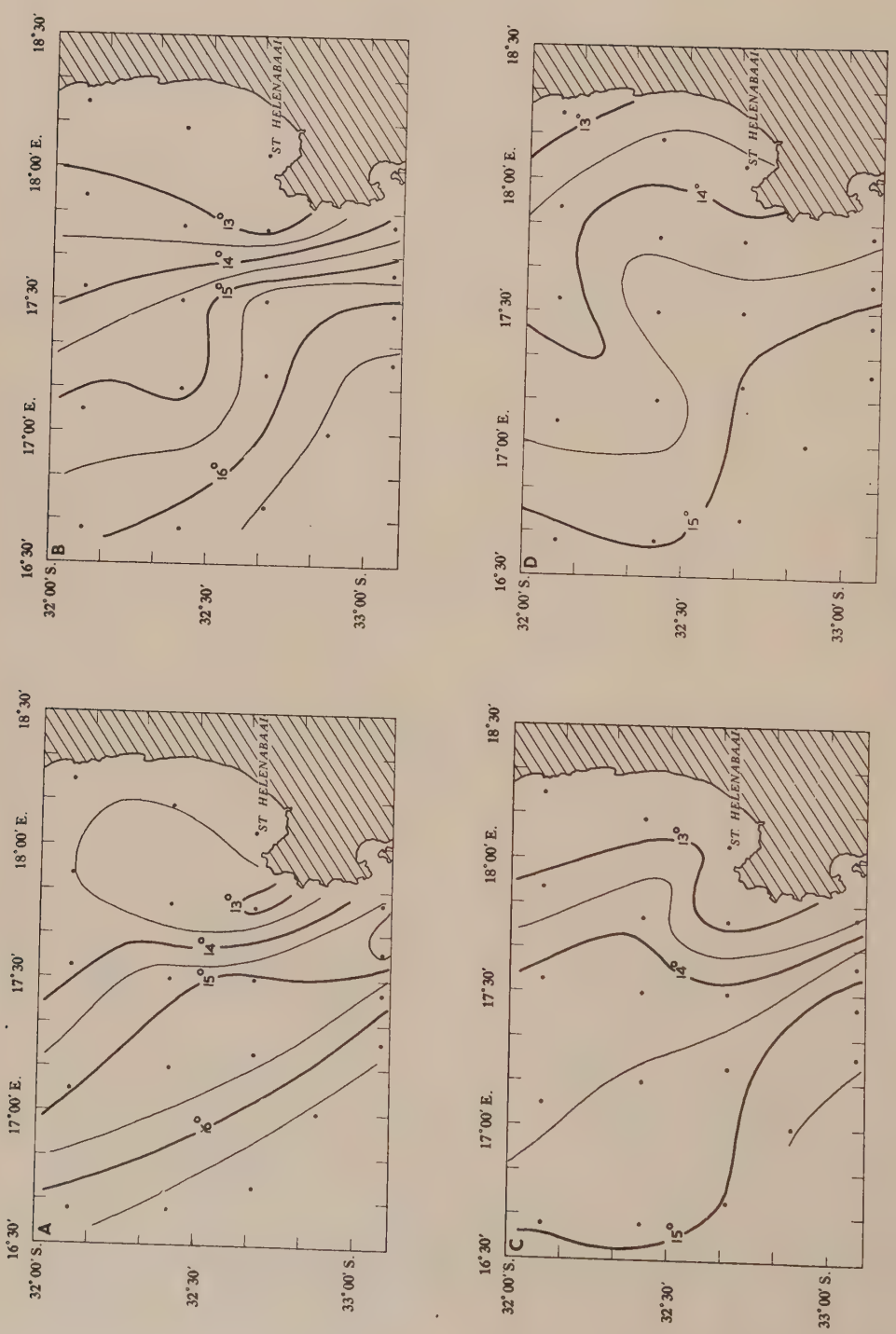

PLATE 13.—Surface temperatures for winter: (A) 1951, (B) 1952, (C) 1953, (D) 1954.

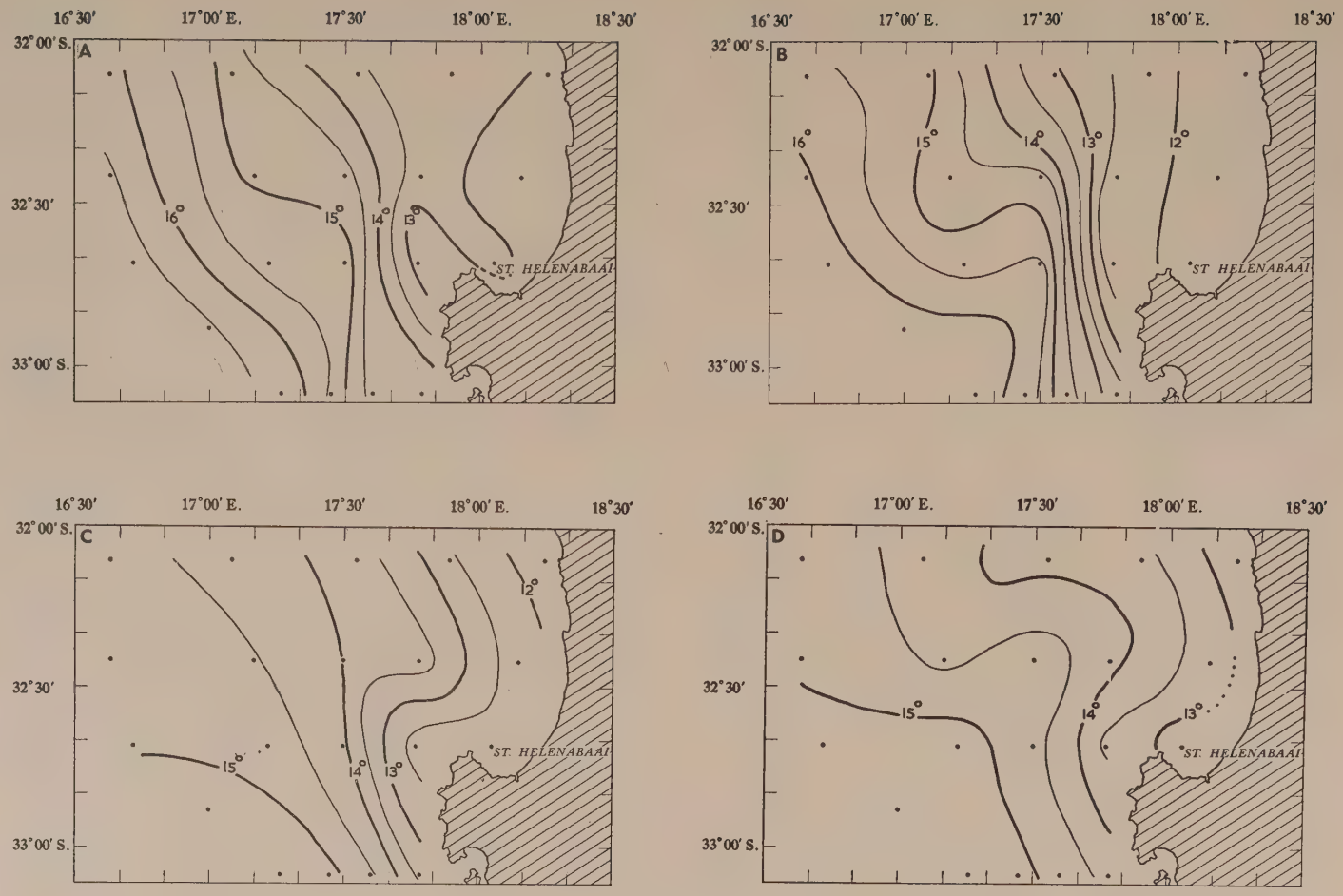

PLATE 14.—20 metres temperatures for winter: (A) 1951, (B) 1952, (C) 1953, (D) 1954.

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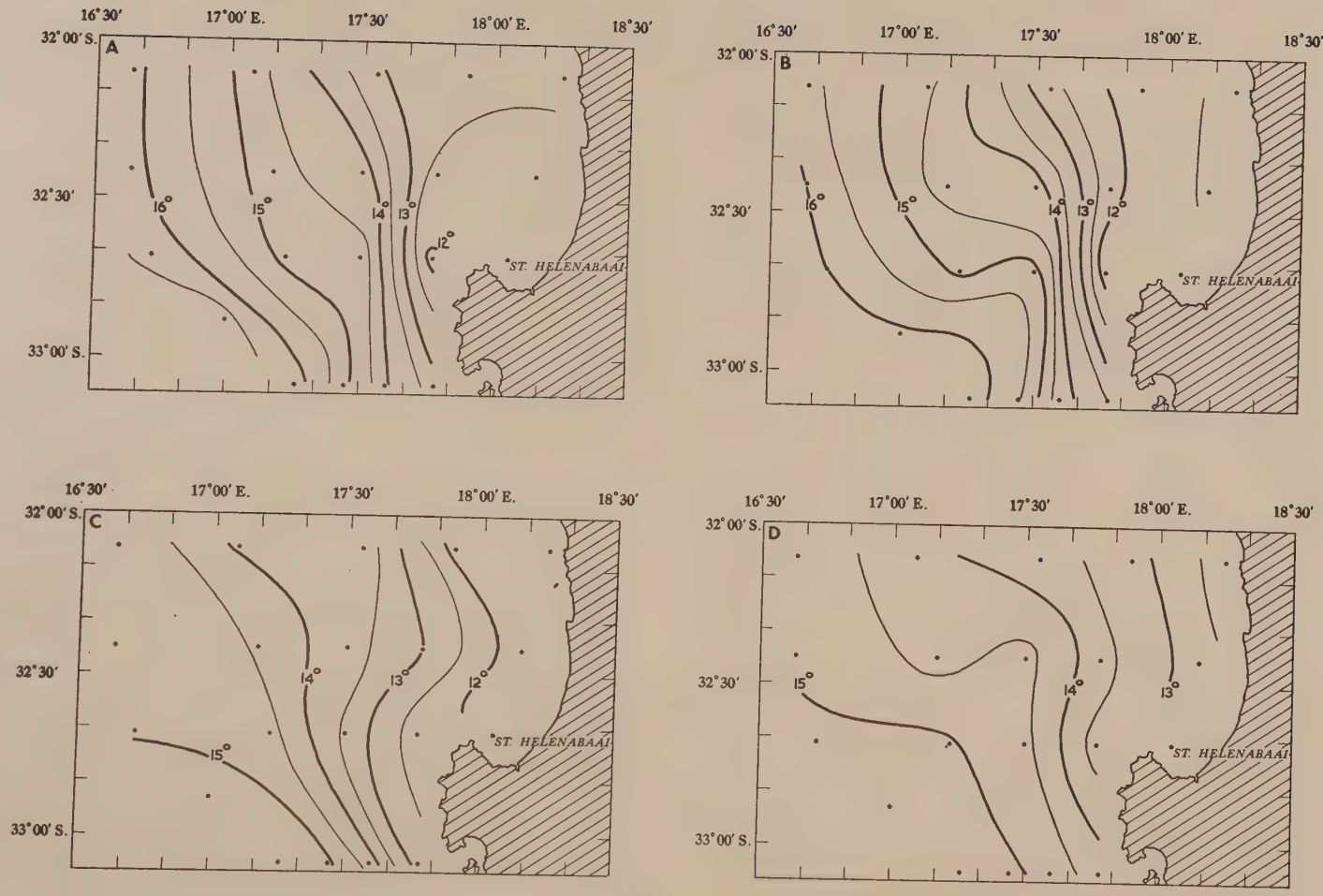

PLATE 15.—0–50 metres mean integral temperatures for winter: (A) 1951, (B) 1952, (C) 1953, (D) 1954.

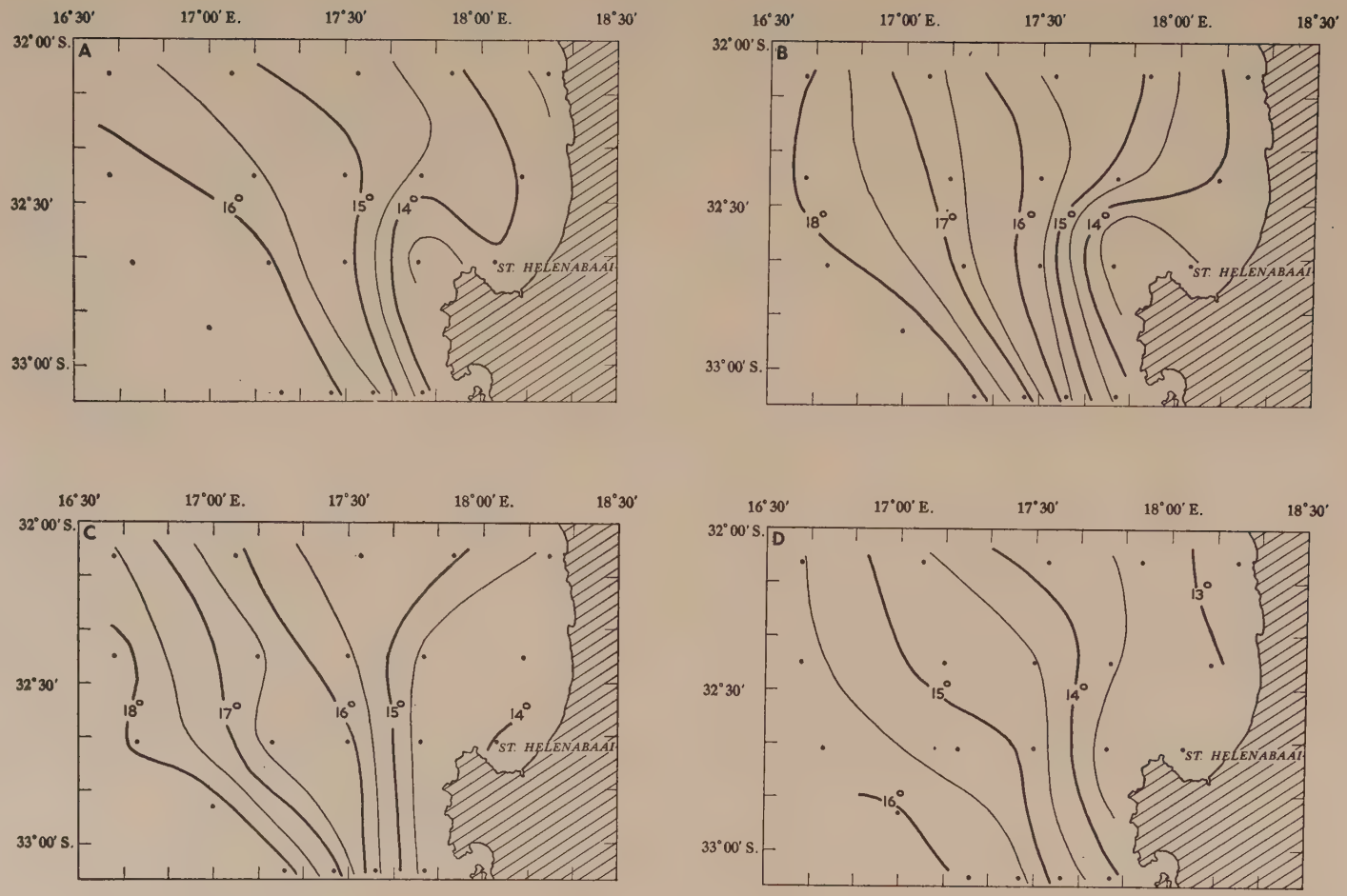

PLATE 16.—Seasonal average of surface temperatures, 1950–54: (A) spring, (B) summer, (C) autumn, (D) winter.

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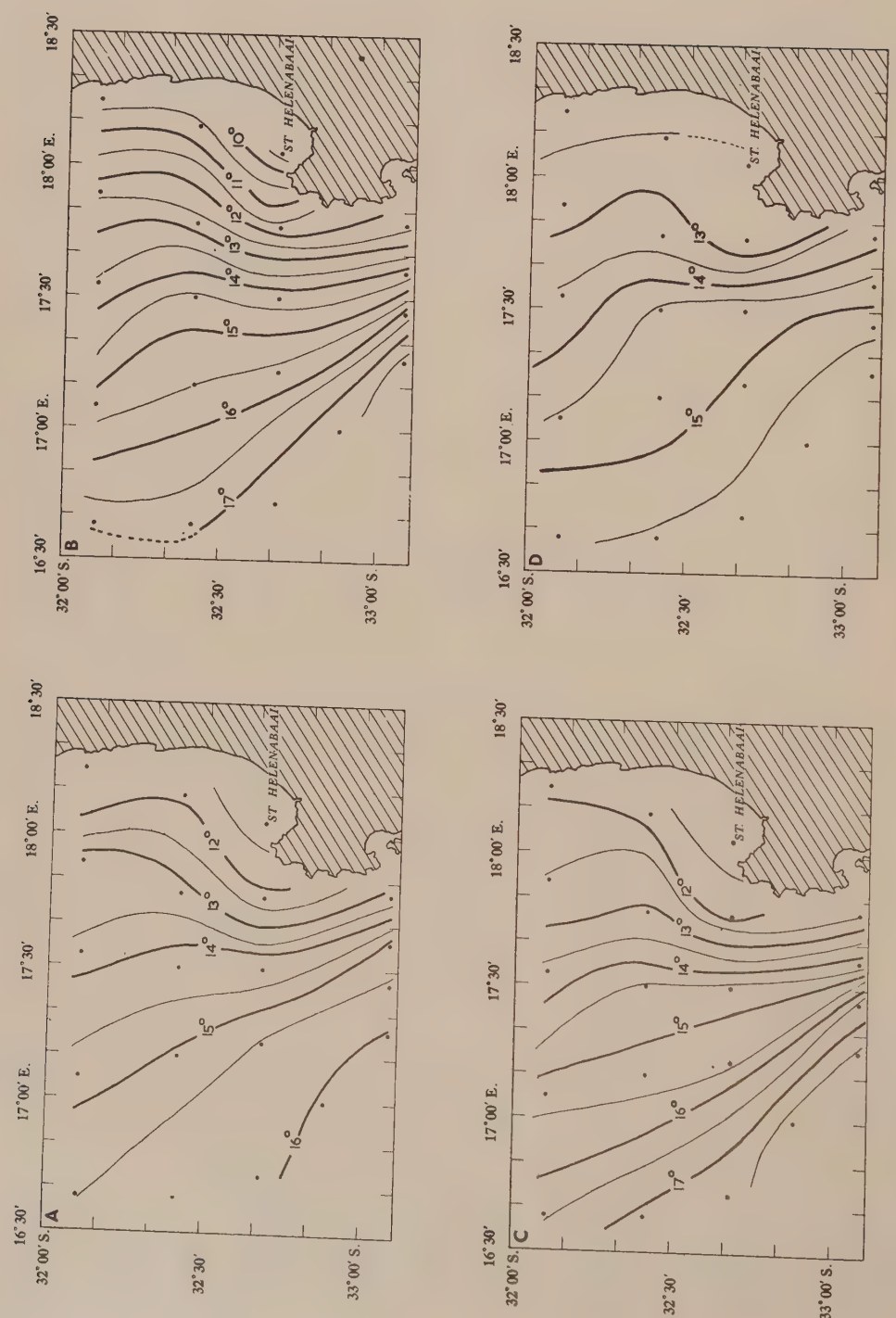

PLATE 17.—Seasonal average of 20 metres temperatures, 1950–54: (A) spring, (B) summer, (C) autumn, (D) winter.

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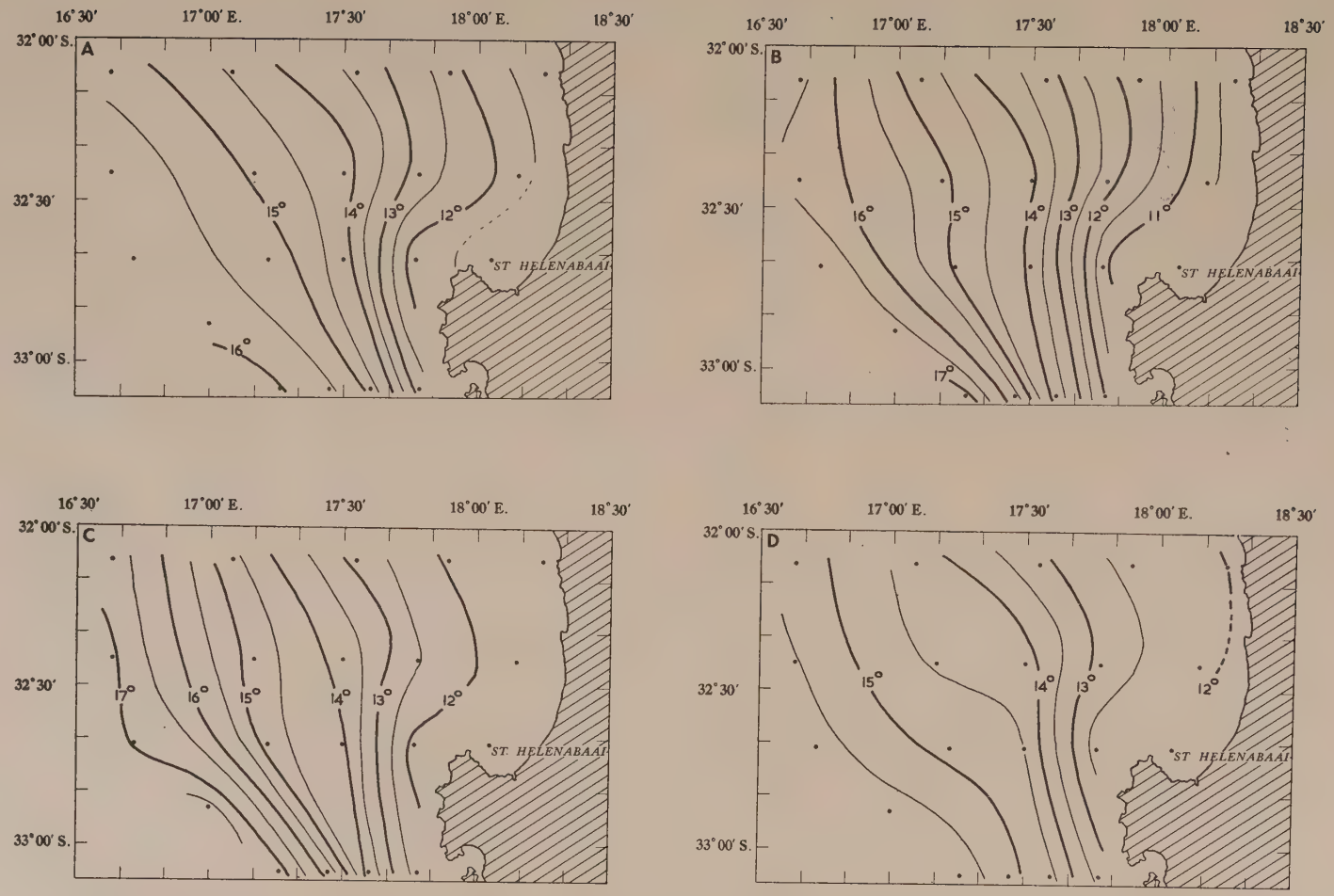

PLATE 18.—Seasonal average of 0–50 metres mean integral temperatures, 1950–54: (A) spring, (B) summer, (C) autumn, (D) winter.

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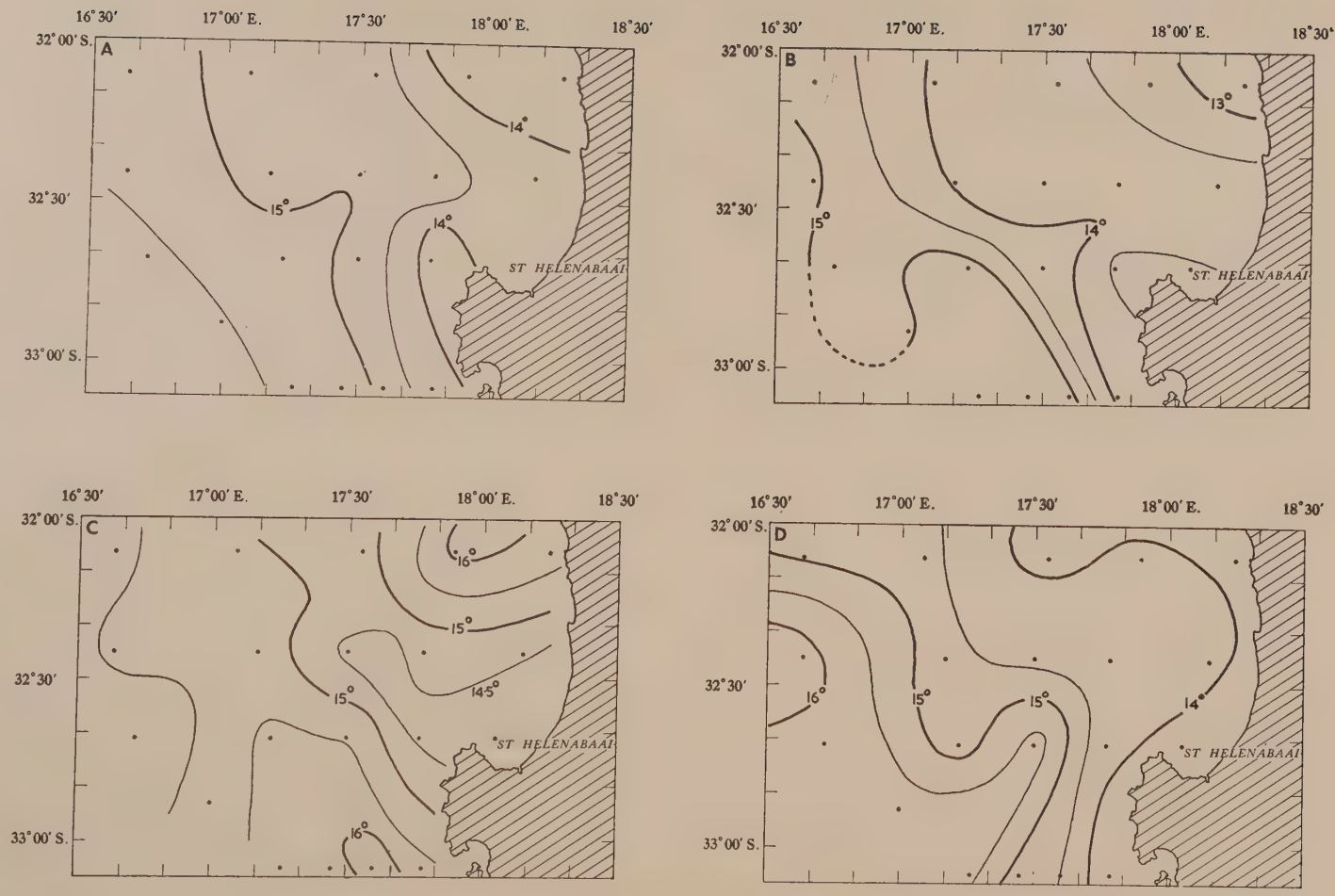

PLATE 19.—Surface temperatures during September: (A) 1950, (B) 1951, (C) 1952, (D) 1953.

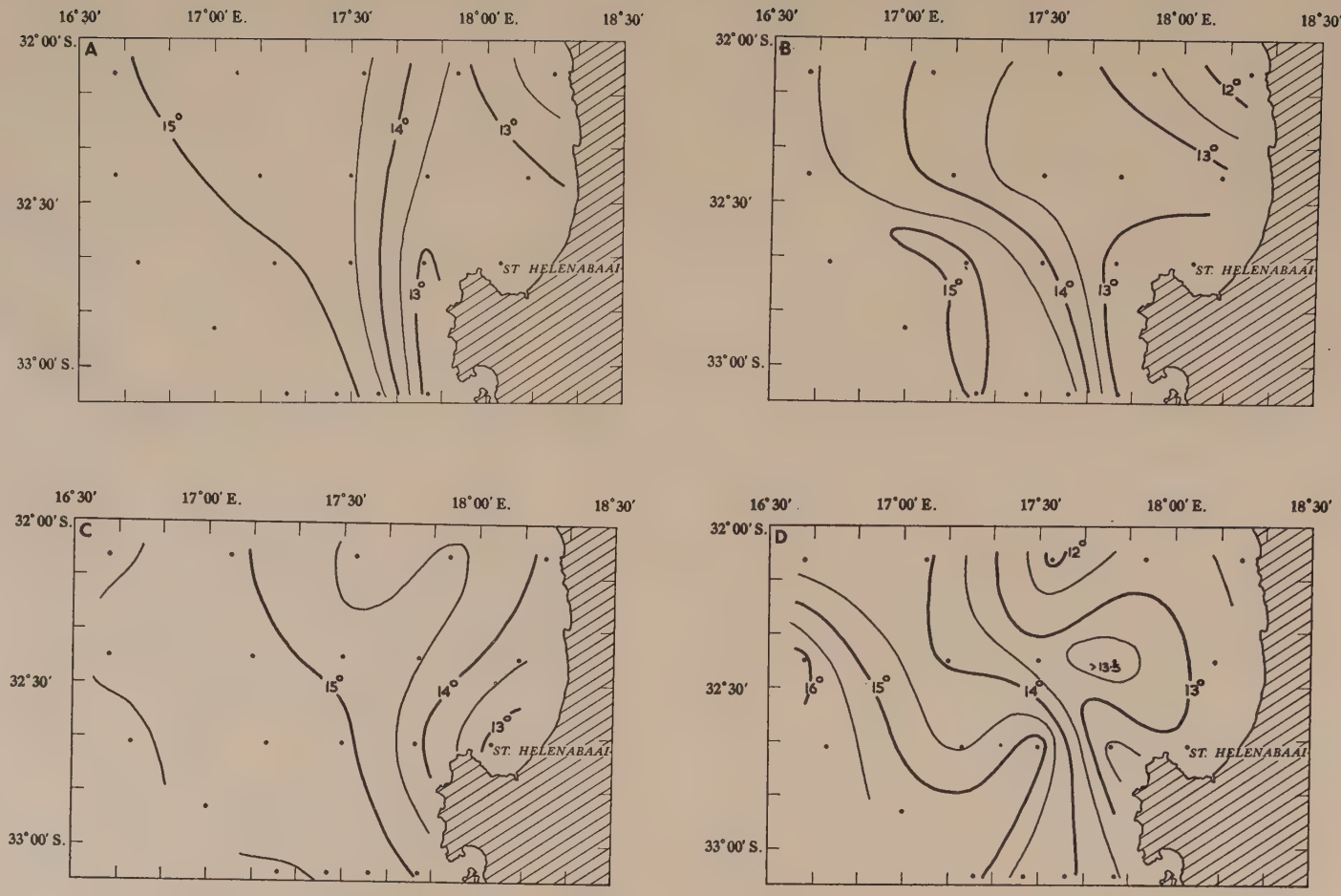

PLATE 20.—20 metres temperatures during September: (A) 1950, (B) 1951, (C) 1952, (D) 1953

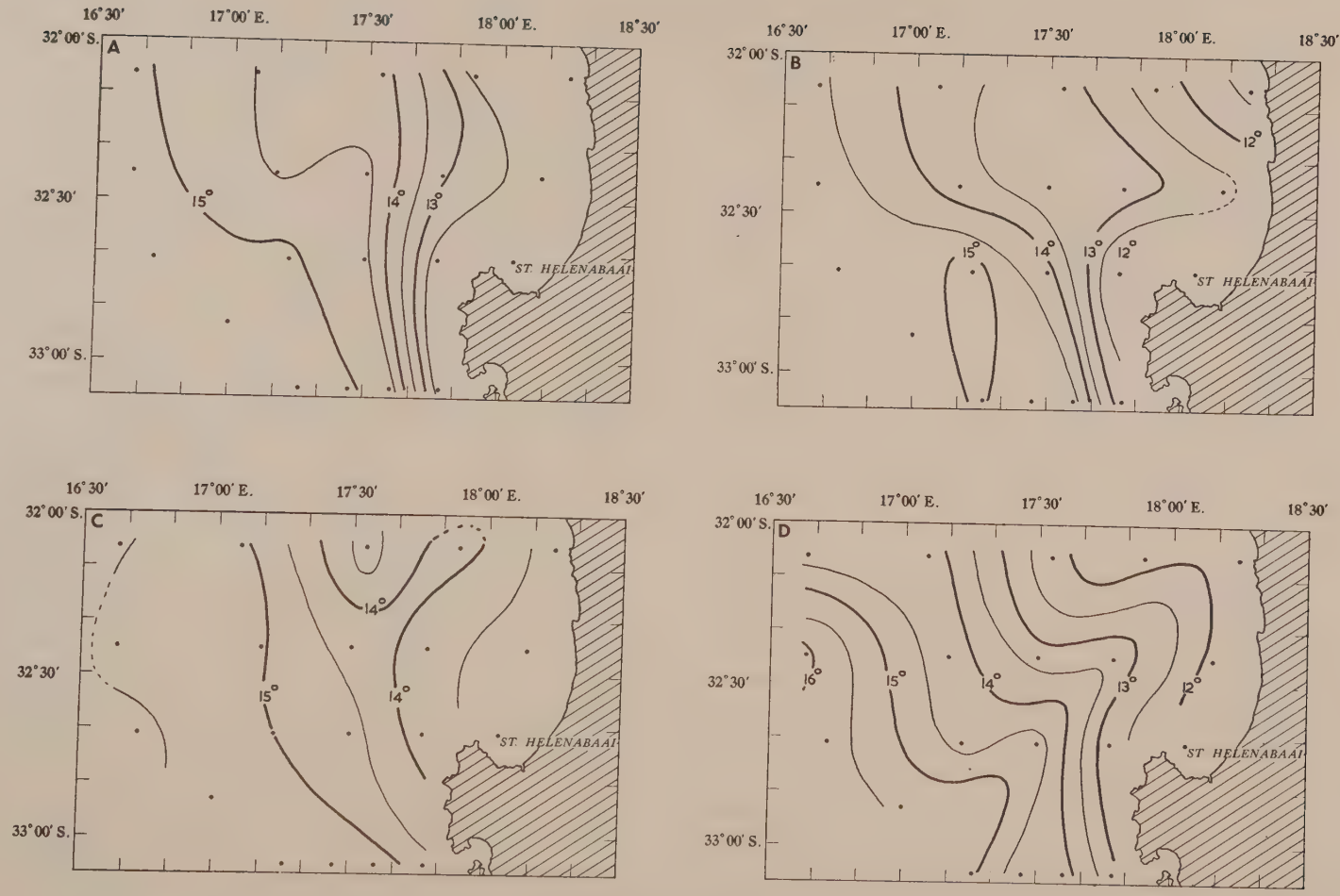

PLATE 21.—0–50 metres mean integral temperatures during September: (A) 1950, (B) 1951, (C) 1952, (D) 1953.

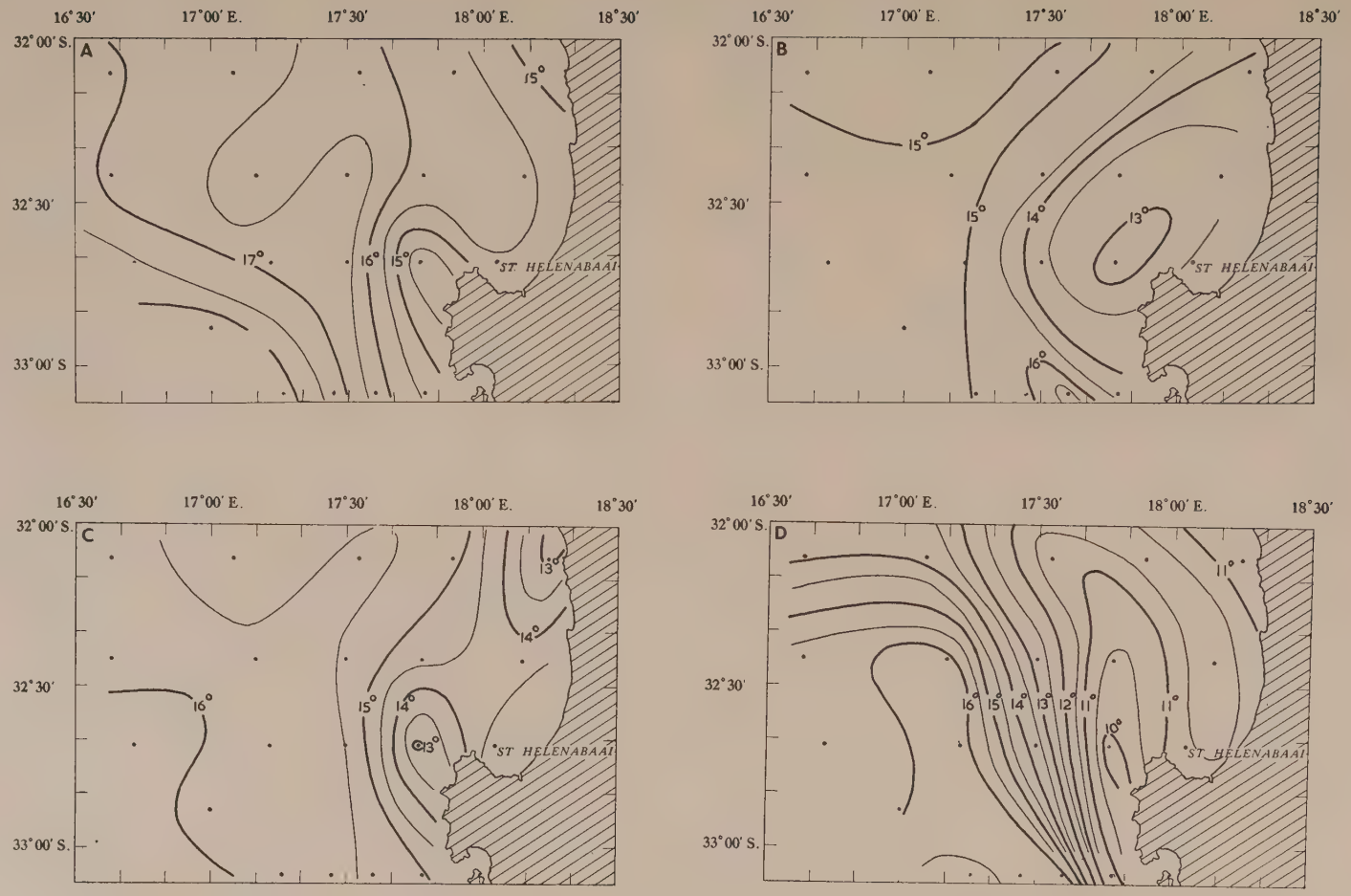

PLATE 22.—Surface temperatures during October: (A) 1950, (B) 1951, (C) 1952, (D) 1953.

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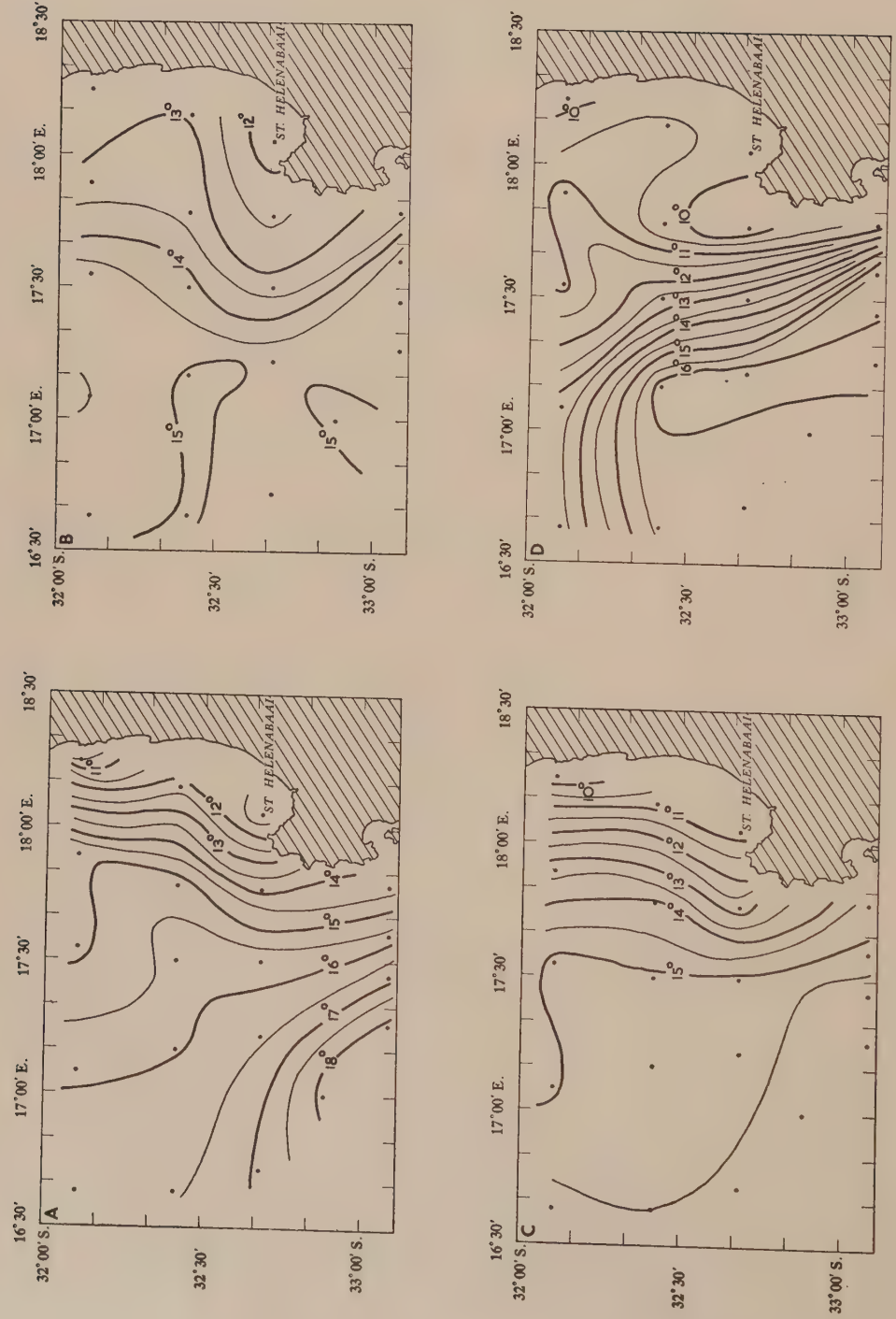

PLATE 23.—20 metres temperatures during October: (A) 1950, (B) 1951, (C) 1952, (D) 1953.

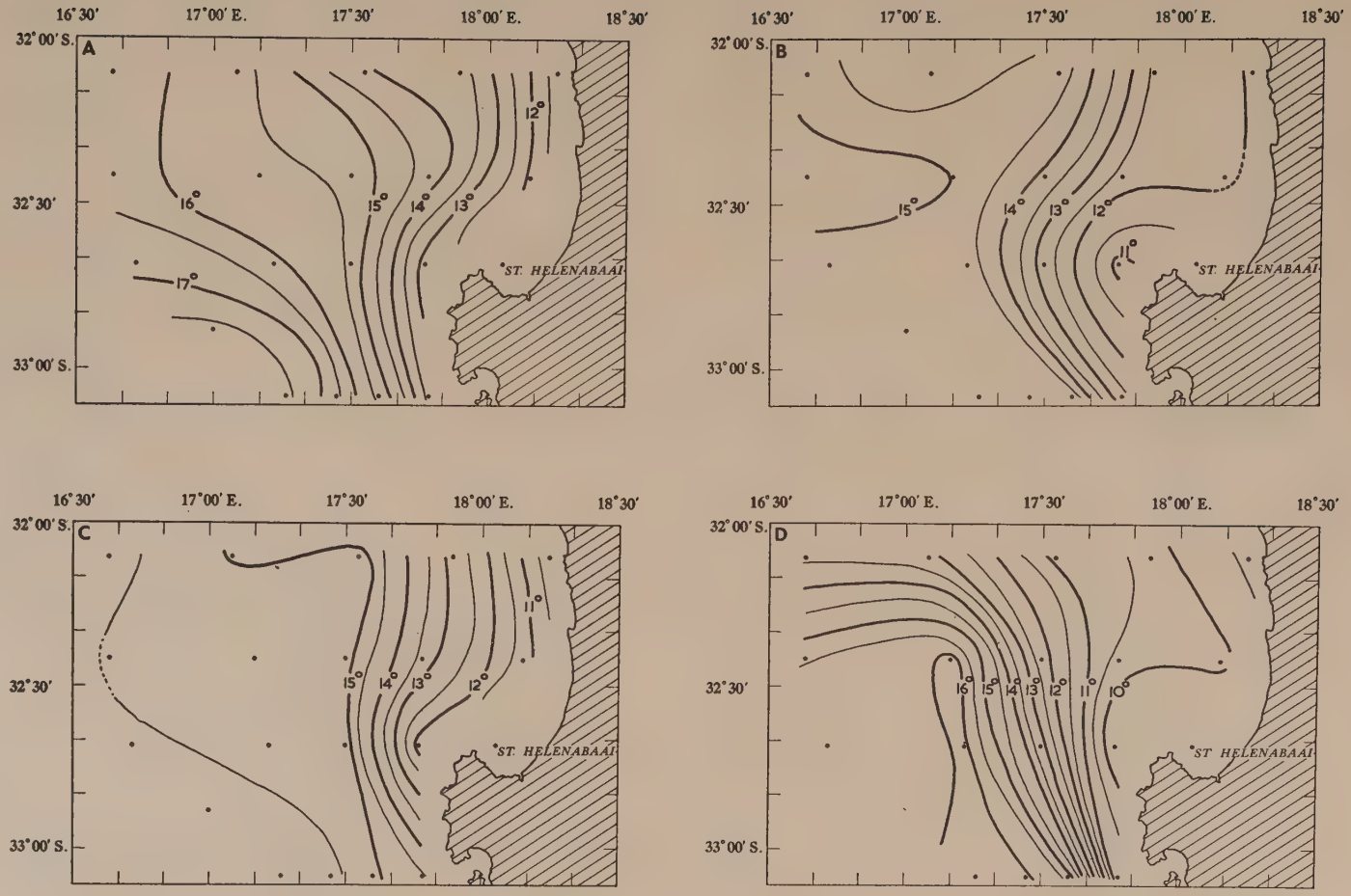

PLATE 24.—0–50 metres mean integral temperatures during October: (A) 1950, (B) 1951, (C) 1952, (D) 1953.

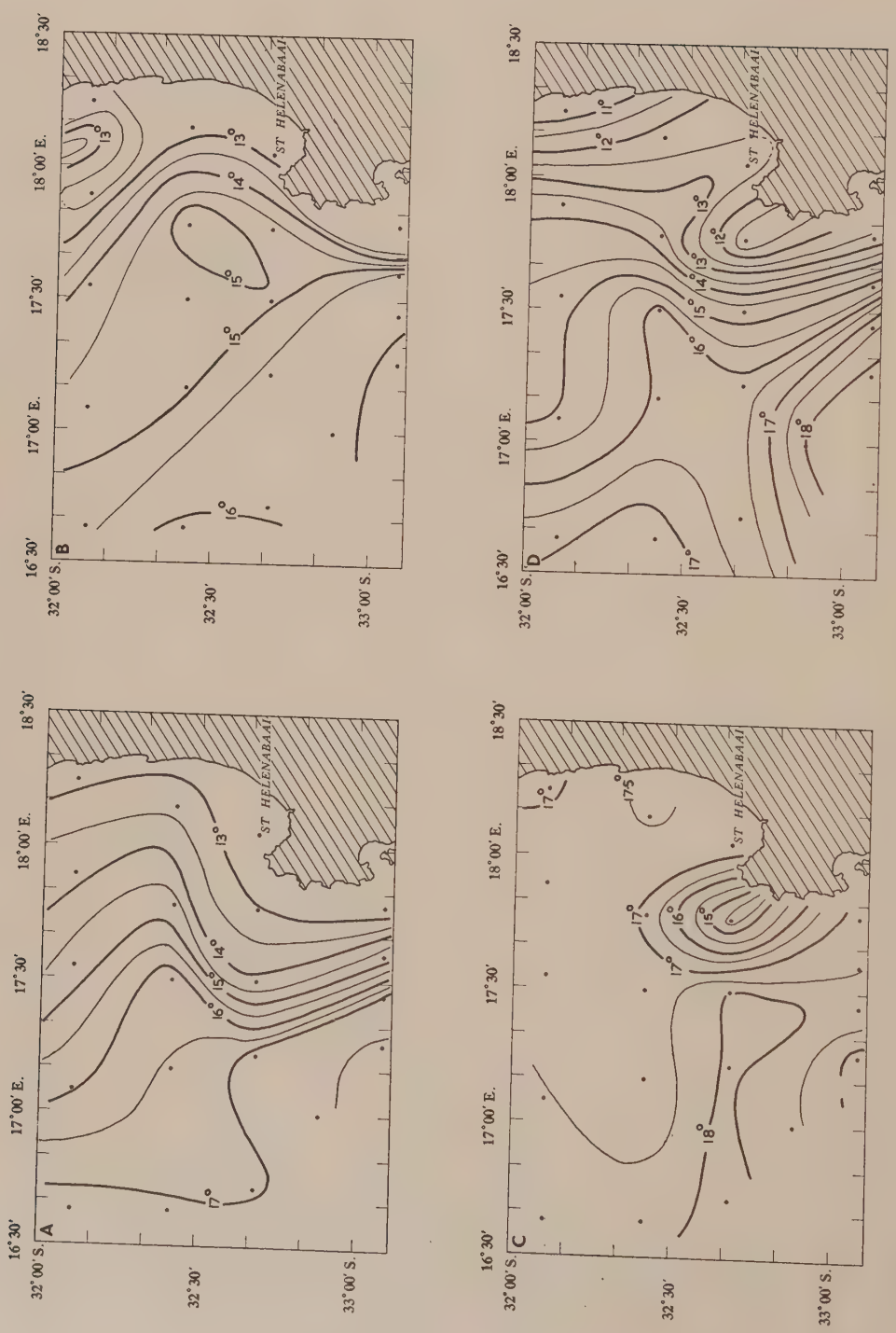

PLATE 25.—Surface temperatures during November: (A) 1950, (B) 1951, (C) 1952, (D) 1953.

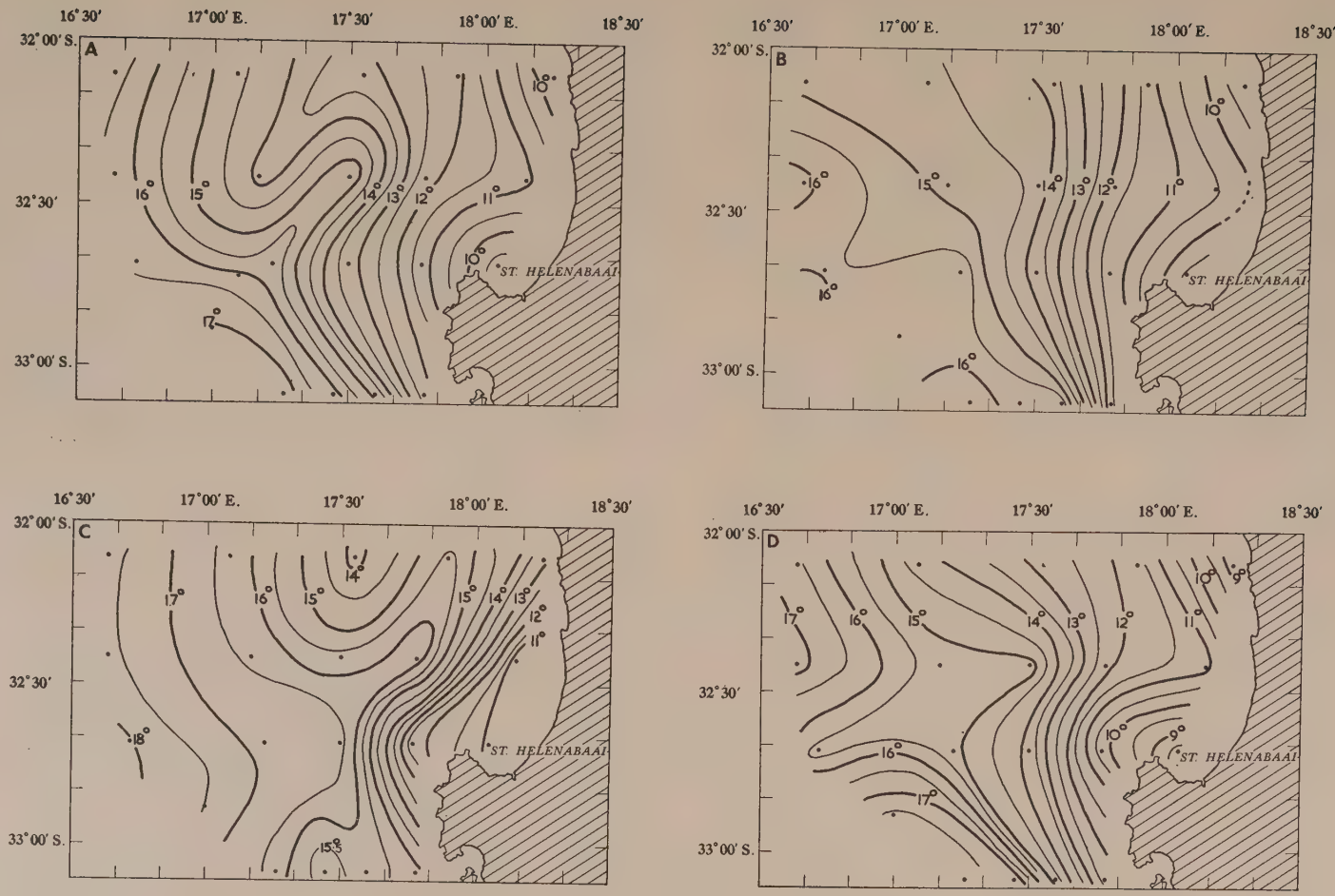

PLATE 26.—20 metres temperatures during November: (A) 1950, (B) 1951, (C) 1952, (D) 1953.

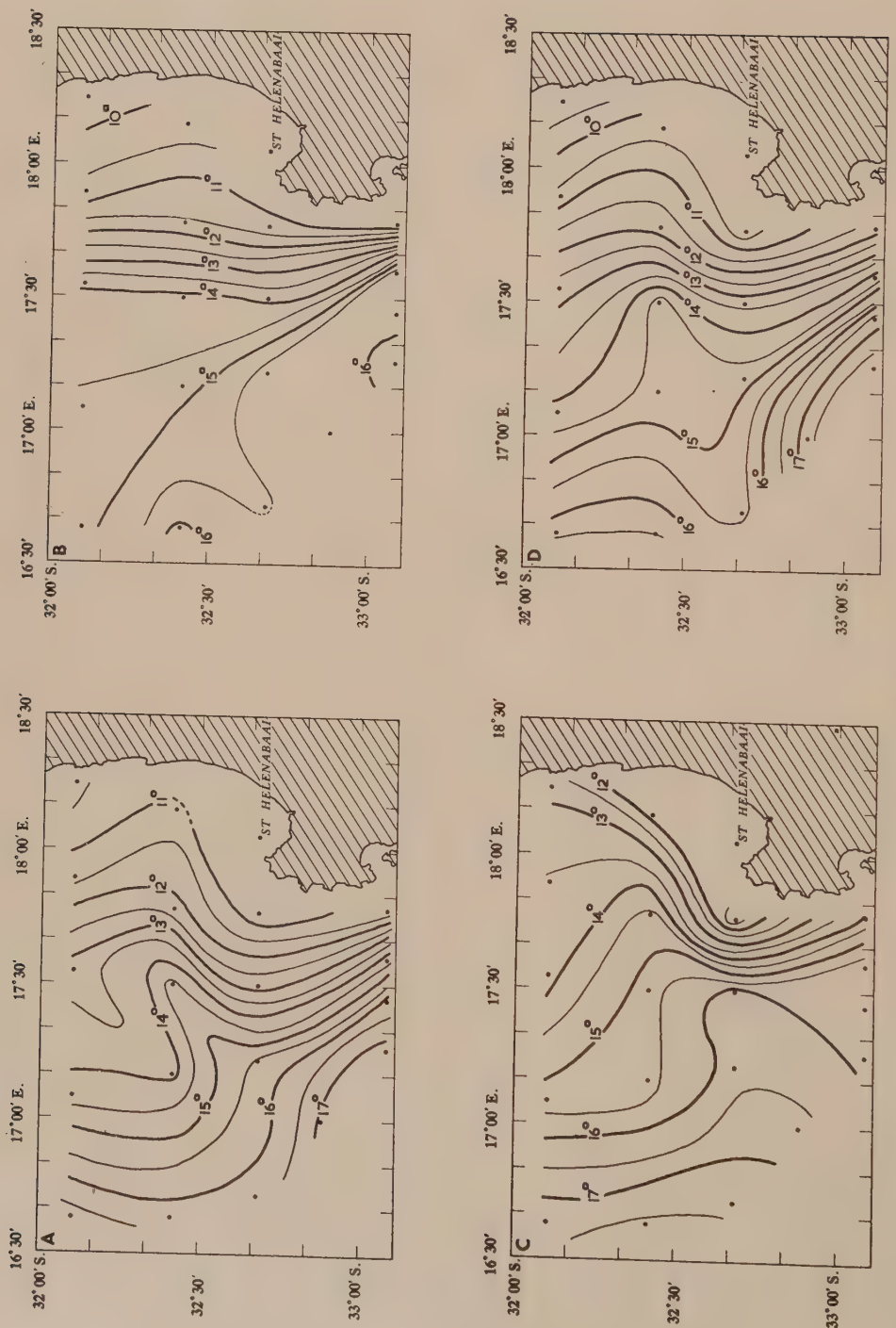

PLATE 27.—0–50 metres mean integral temperatures during November: (A) 1950, (B) 1951, (C) 1952, (D) 1953.

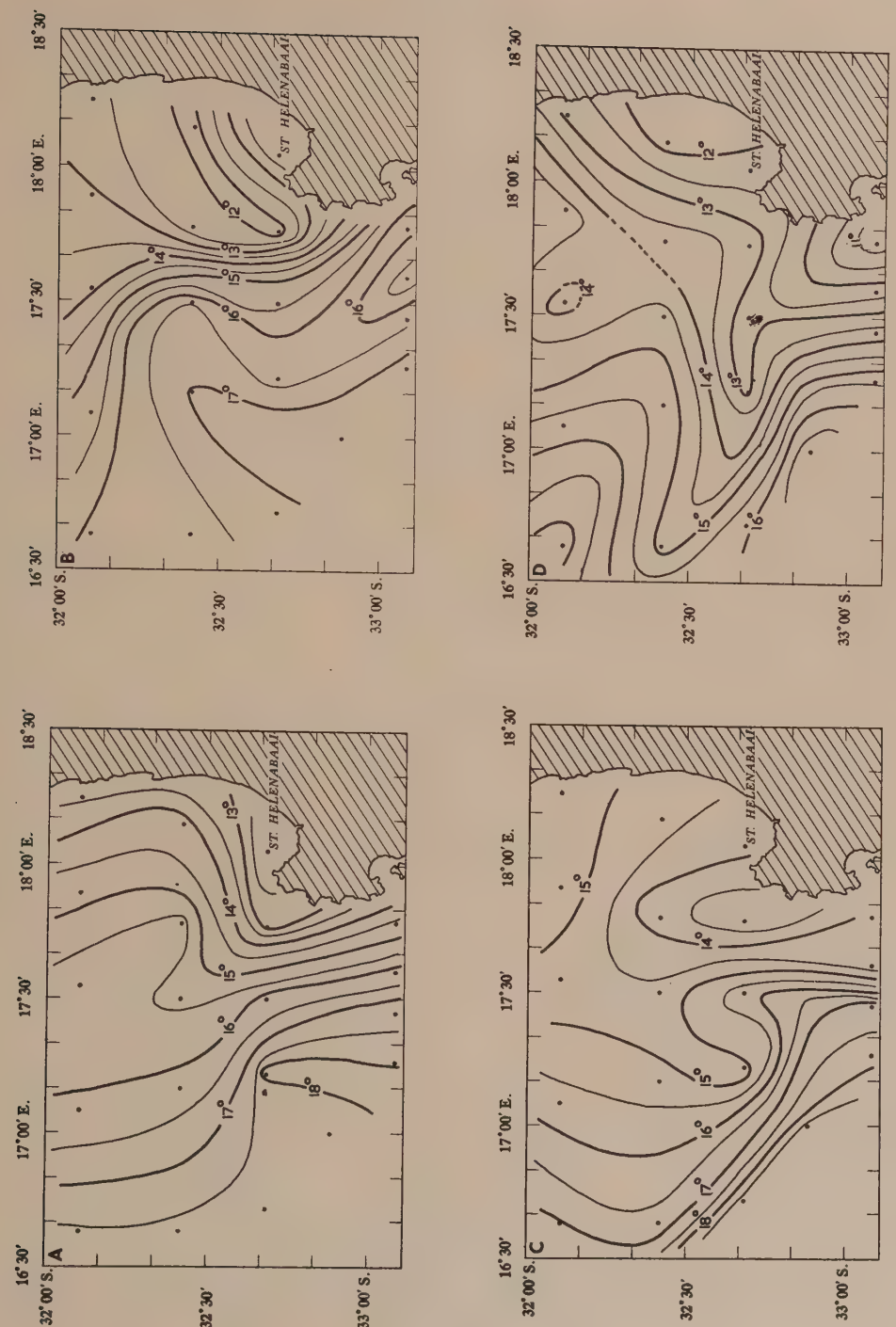

PLATE 28.—Surface temperatures during December: (A) 1950, (B) 1951, (C) 1952, (D) 1953.

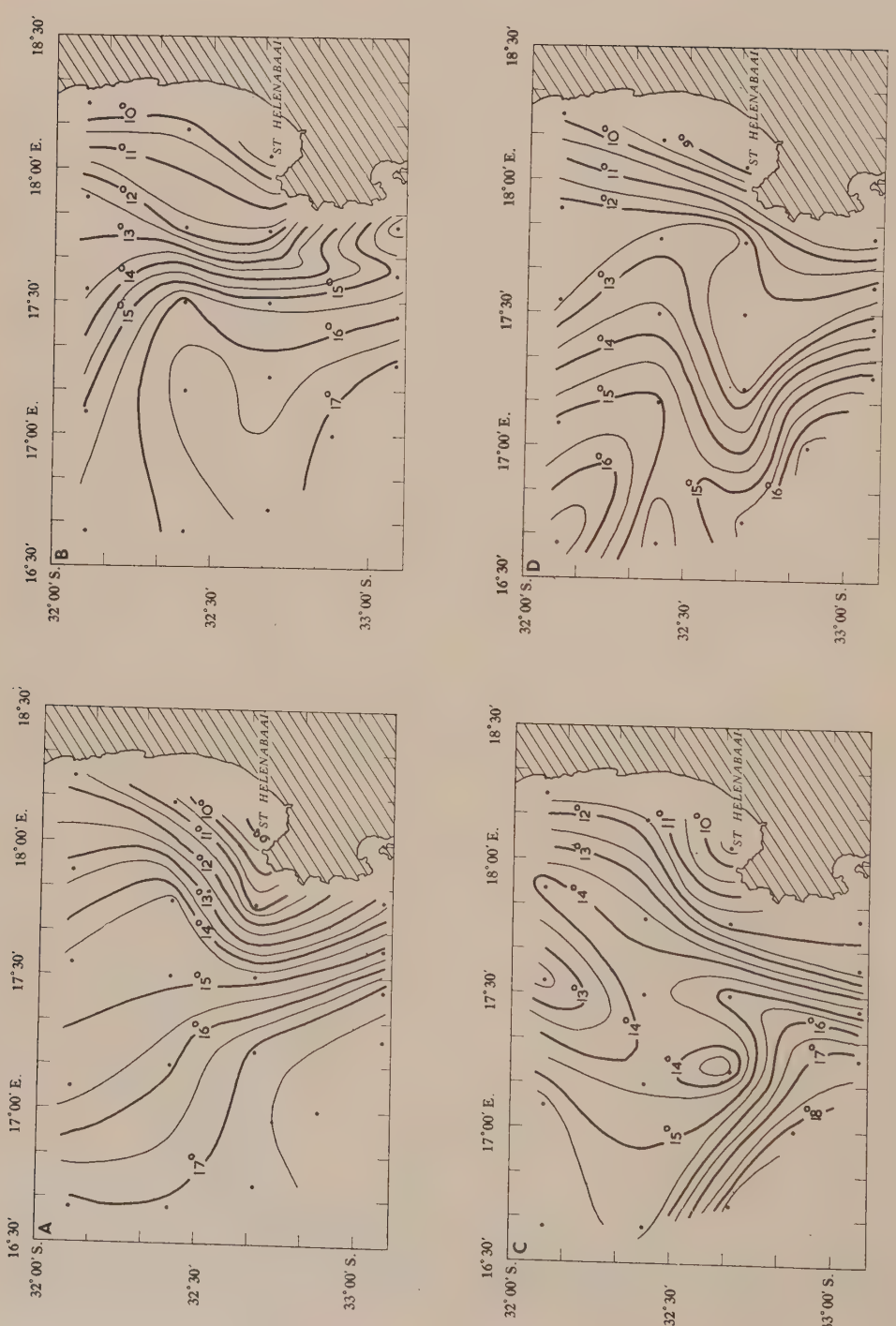

PLATE 29.—20 metres temperatures during December: (A) 1950, (B) 1951, (C) 1952, (D) 1953.

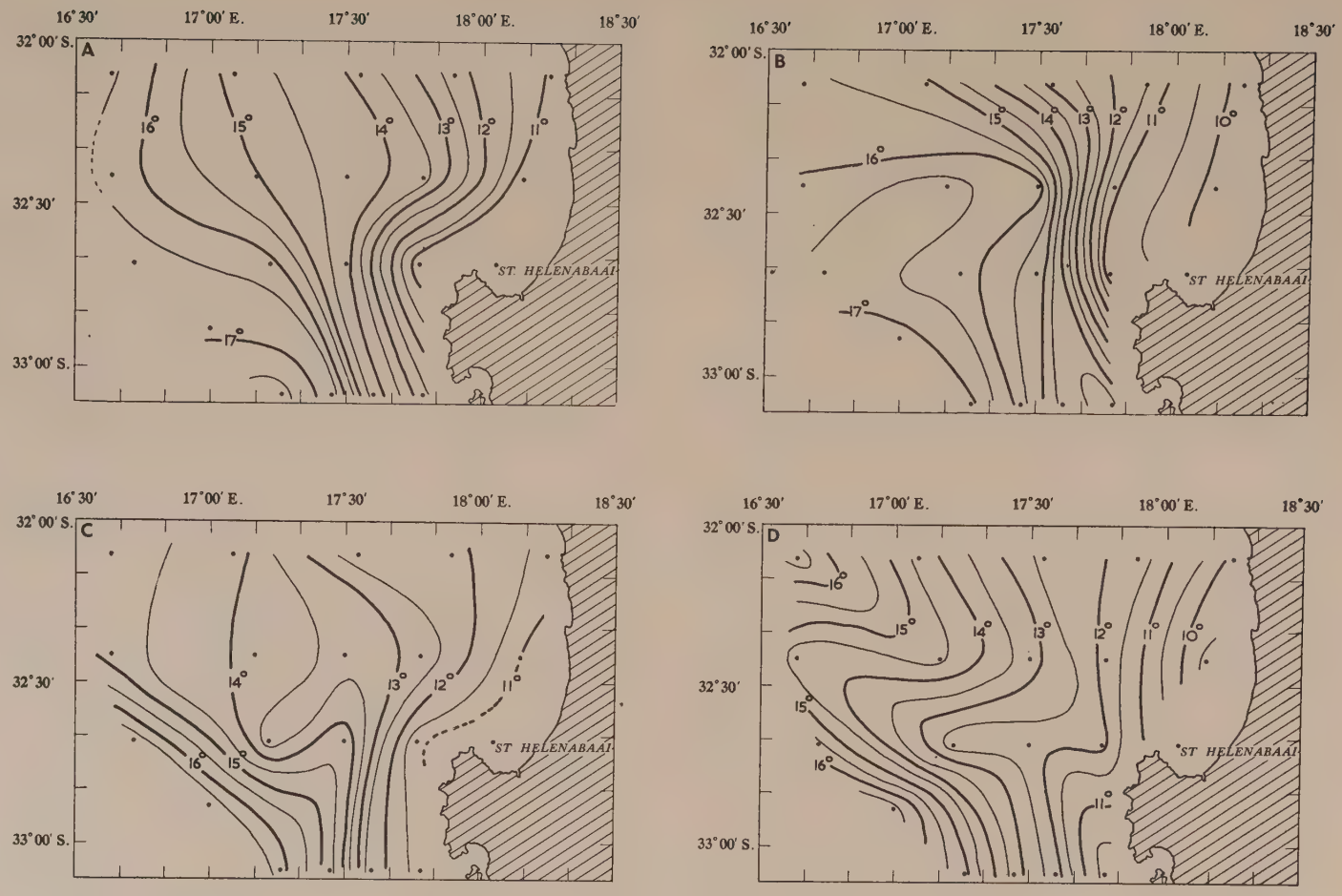

PLATE 30.—0–50 metres mean integral temperatures during December: (A) 1950, (B) 1951, (C) 1952, (D) 1953.

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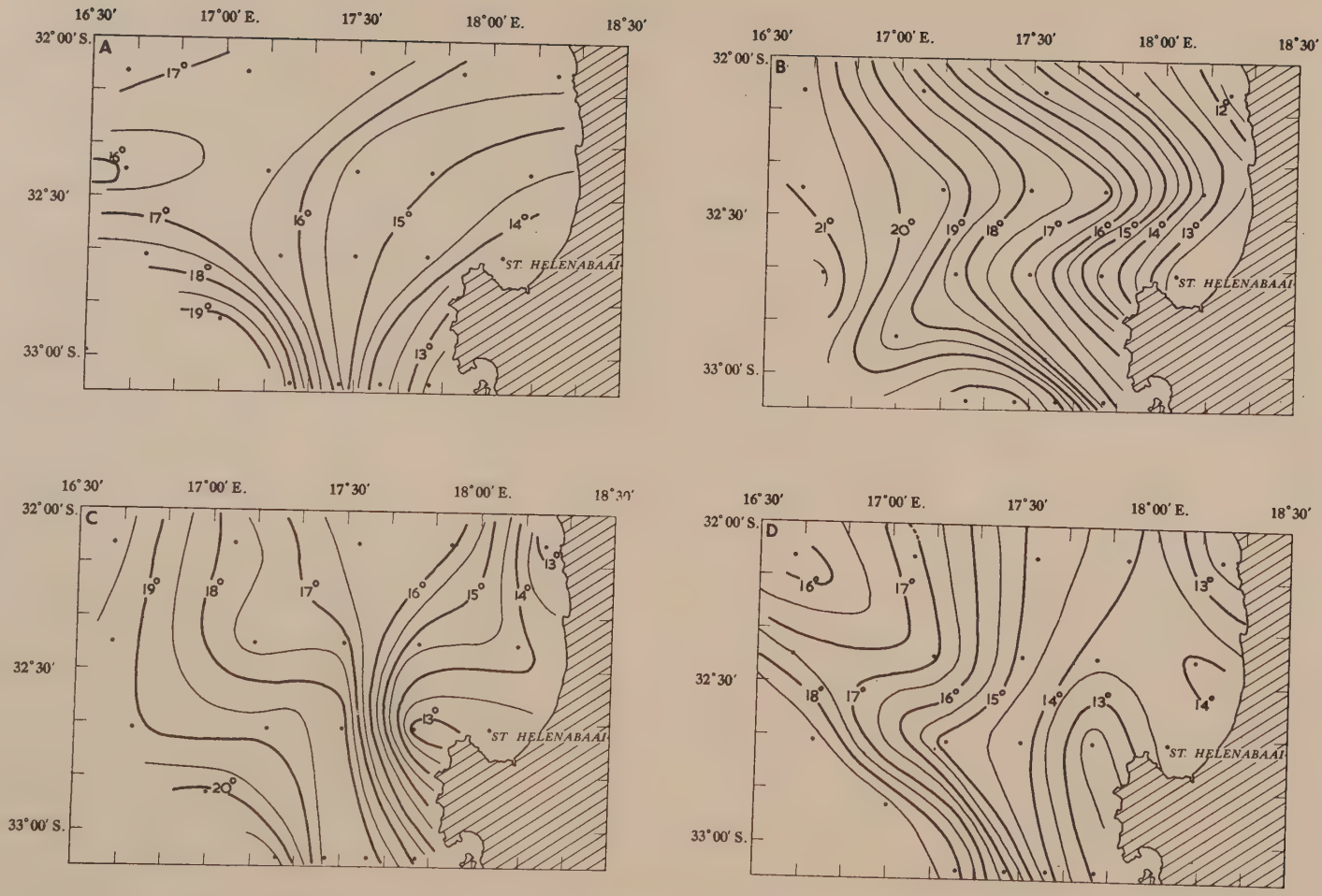

PLATE 31.—Surface temperatures during January: (A) 1951, (B) 1952, (C) 1953, (D) 1954

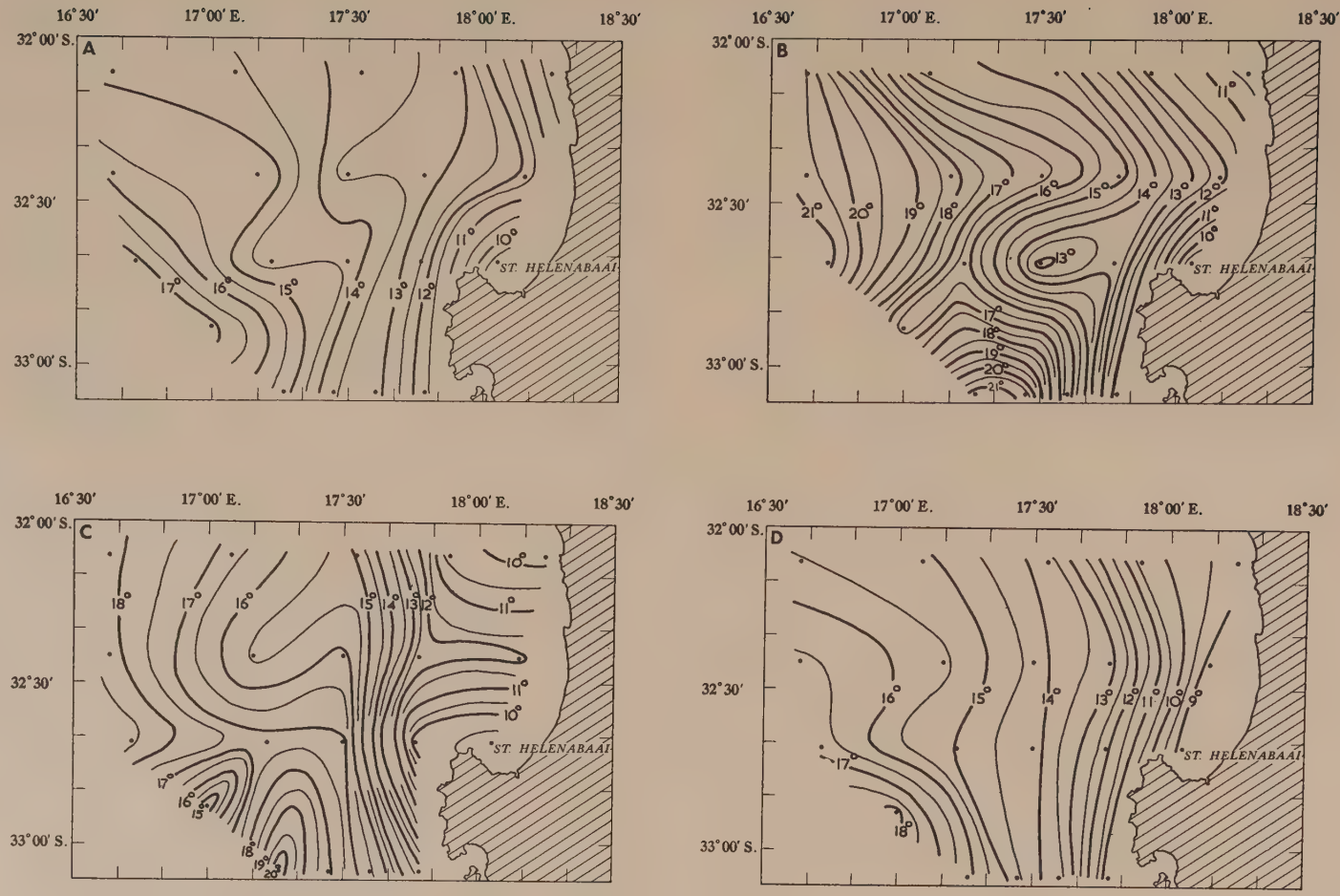

PLATE 32.—20 metres temperatures during January: (A) 1951, (B) 1952, (C) 1953, (D) 1954.

Reprint from "Commerce & Industry", August, 1957

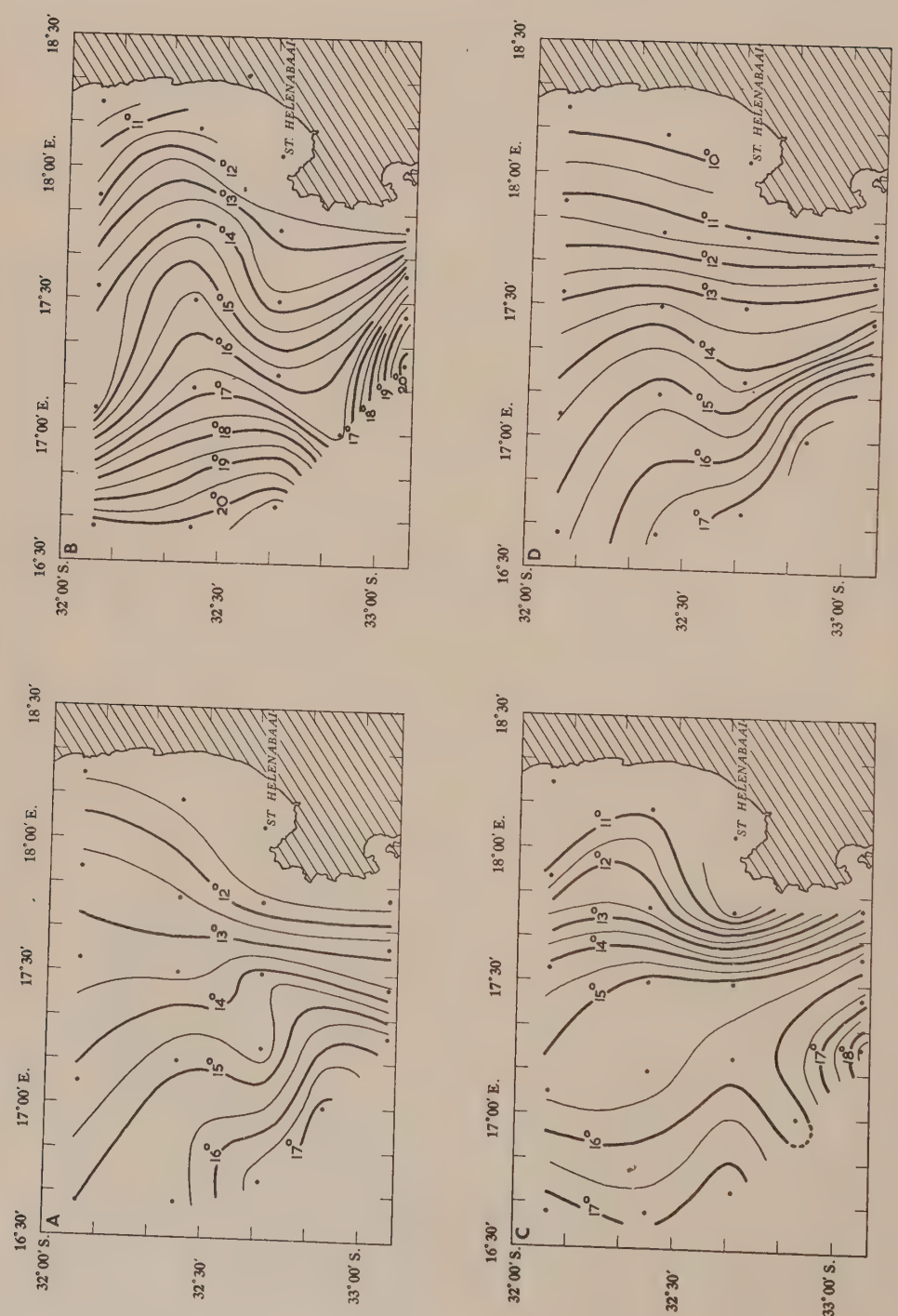

PLATE 33.—0–50 metres mean integral temperatures during January: (A) 1951, (B) 1952, (C) 1953, (D) 1954.

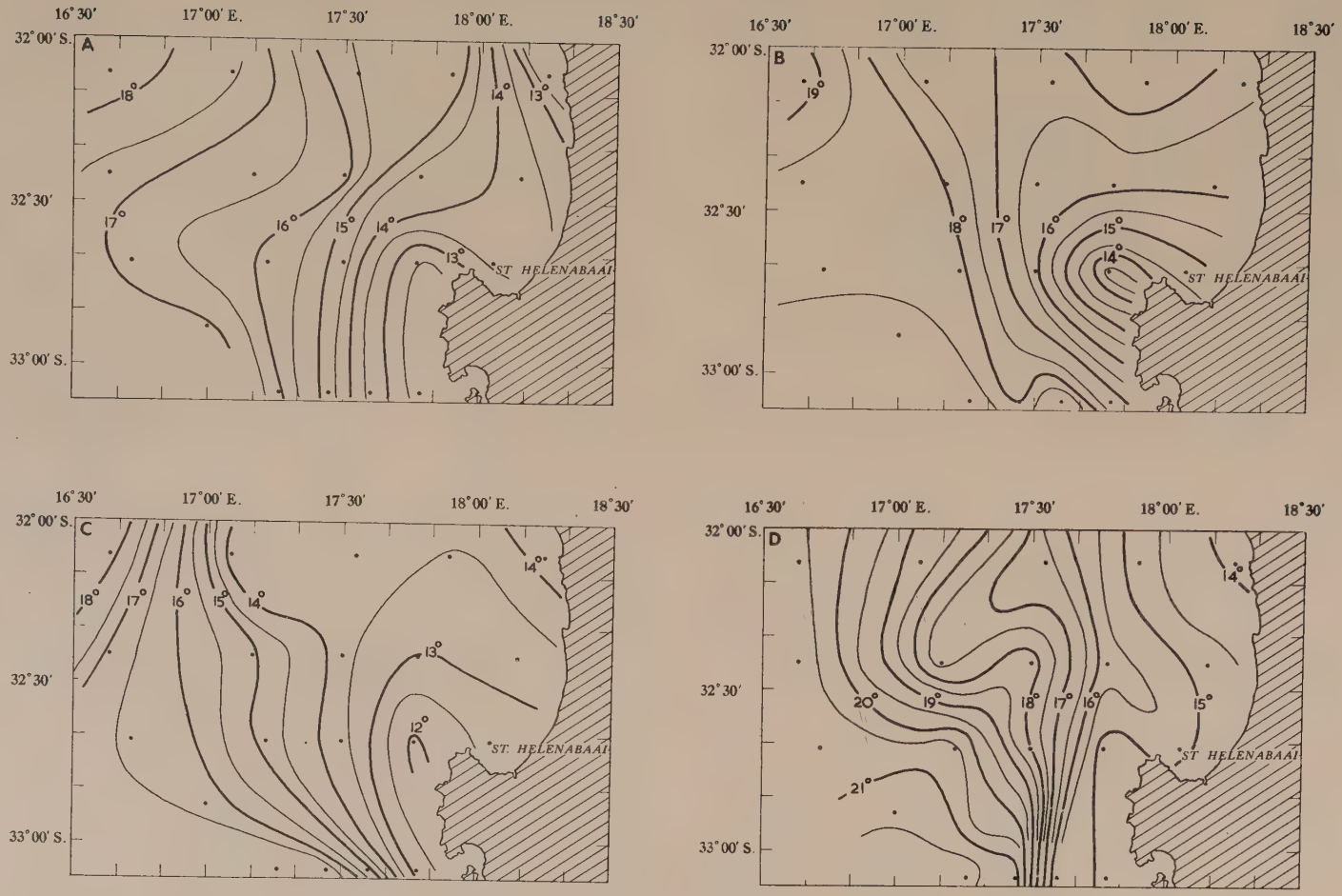

PLATE 34.—Surface temperatures during February: (A) 1951, (B) 1952, (C) 1953, (D) 1954.

Reprint from "Commerce & Industry", August, 1957

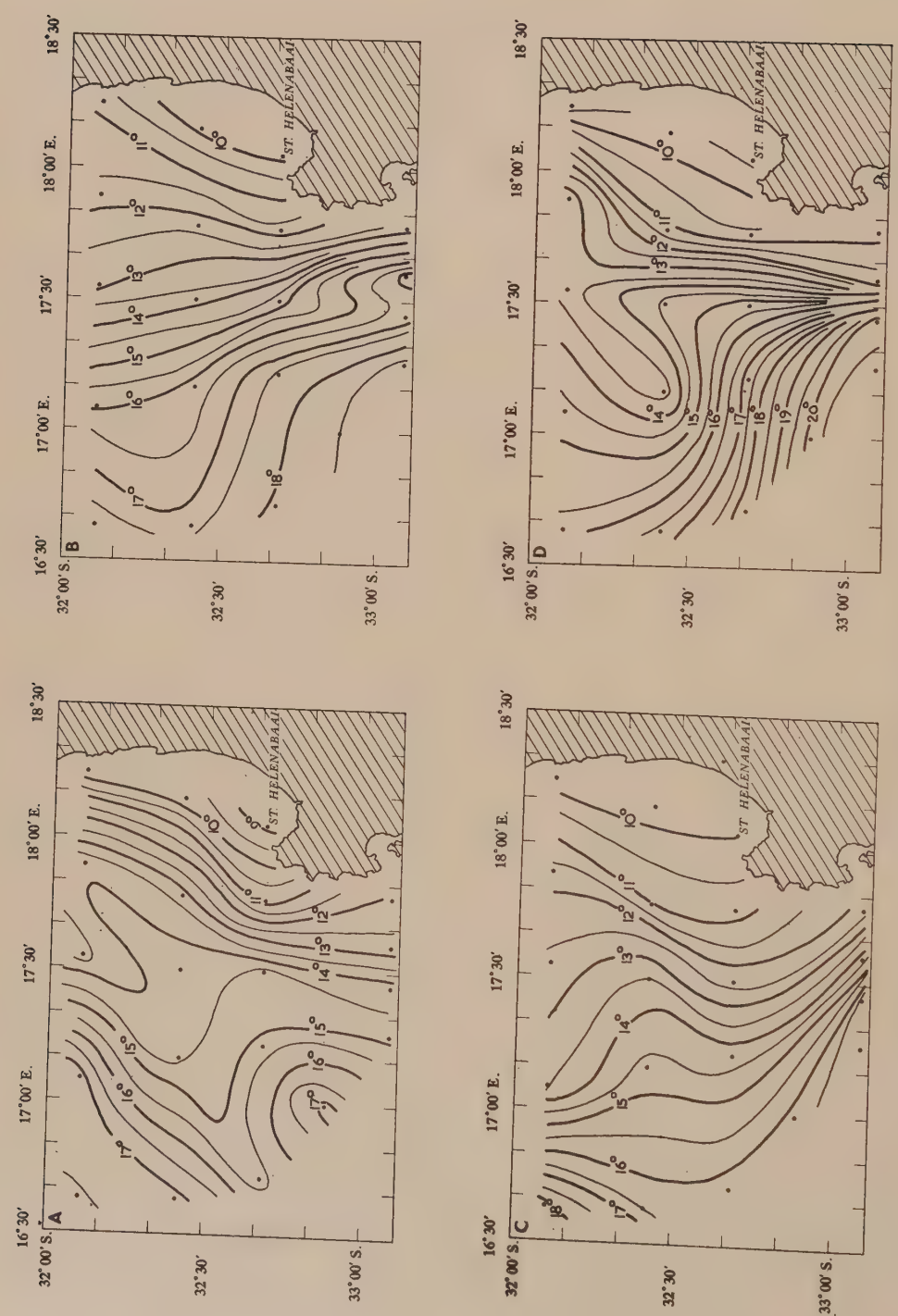

PLATE 35.—20 metres temperatures during February: (A) 1951, (B) 1952, (C) 1953, (D) 1954.

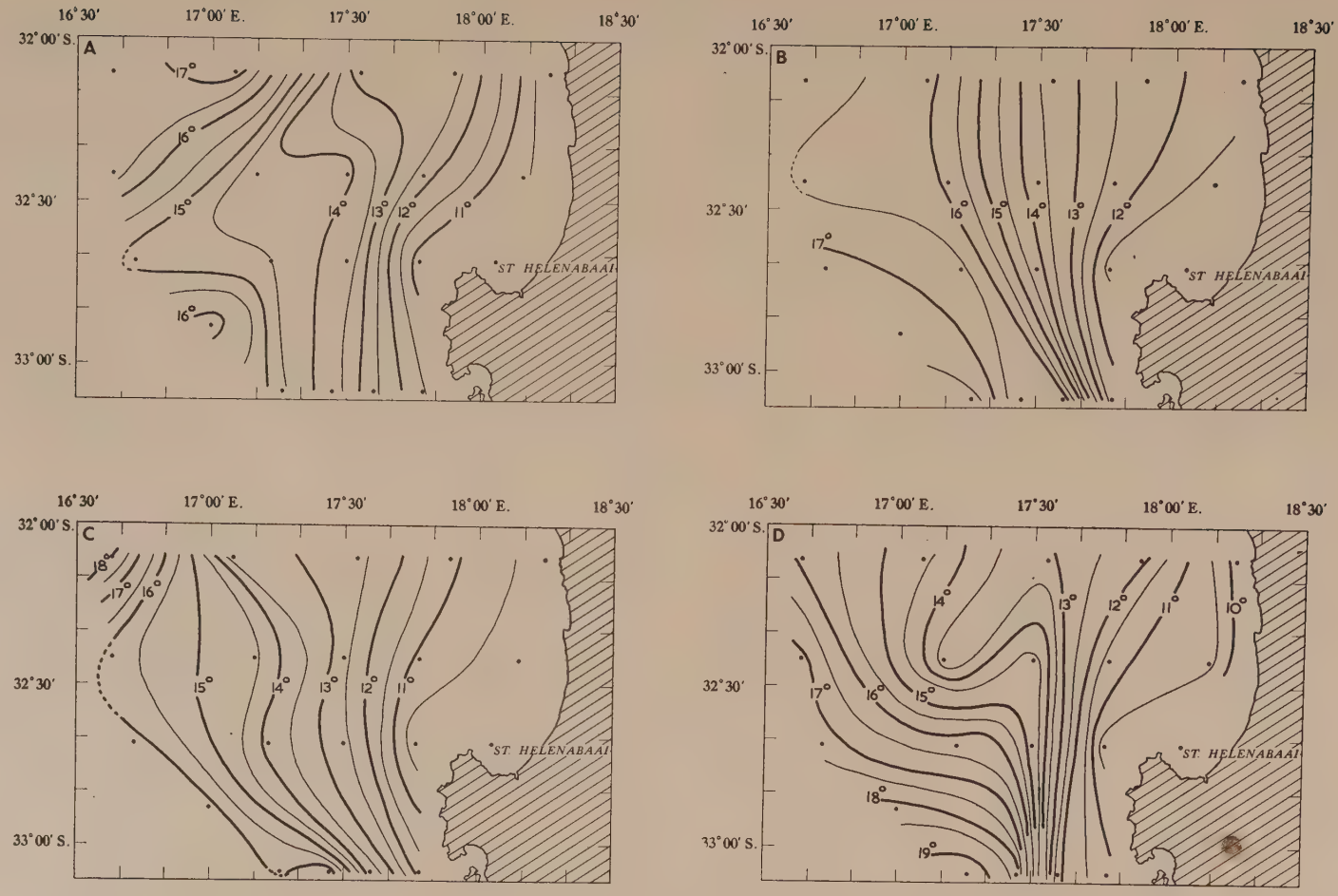

PLATE 36.—0–50 metres mean integral temperatures during February: (A) 1951, (B) 1952, (C) 1953, (D) 1954.

Reprint from "Commerce & Industry", August, 1957

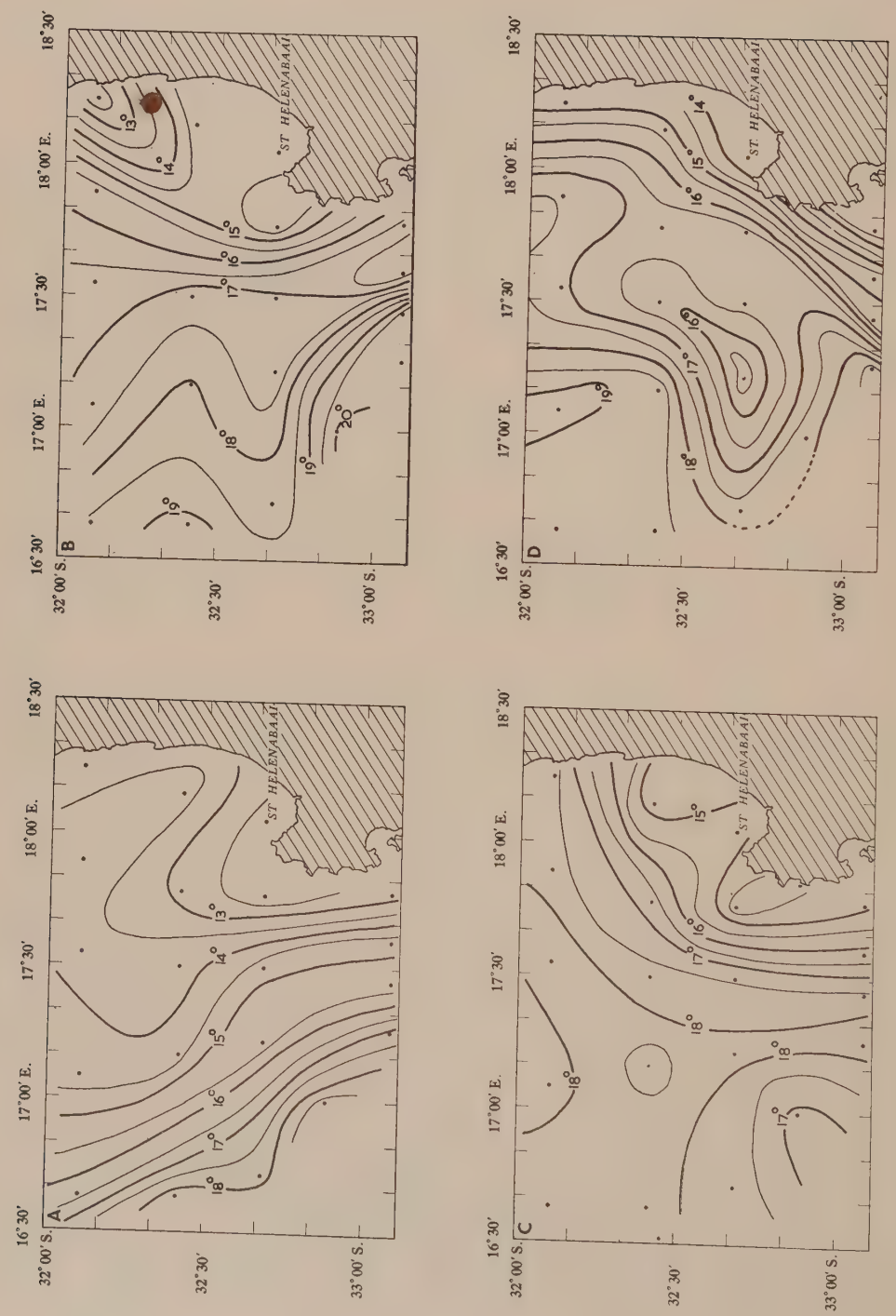

PLATE 37.—Surface temperatures during March: (A) 1951, (B) 1952, (C) 1953, (D) 1954.

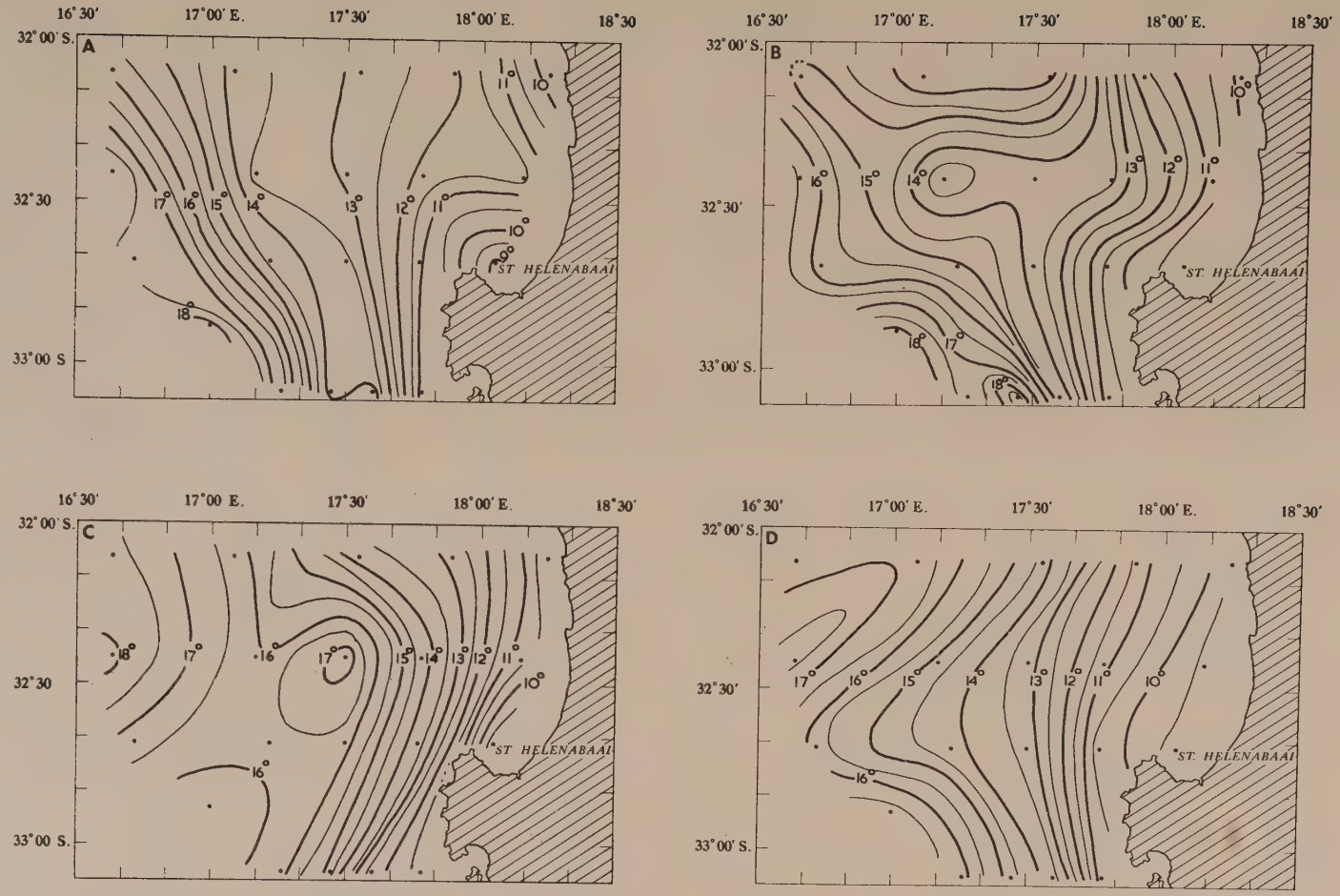

PLATE 38.—20 metres temperatures during March: (A) 1951, (B) 1952, (C) 1953, (D) 1954.

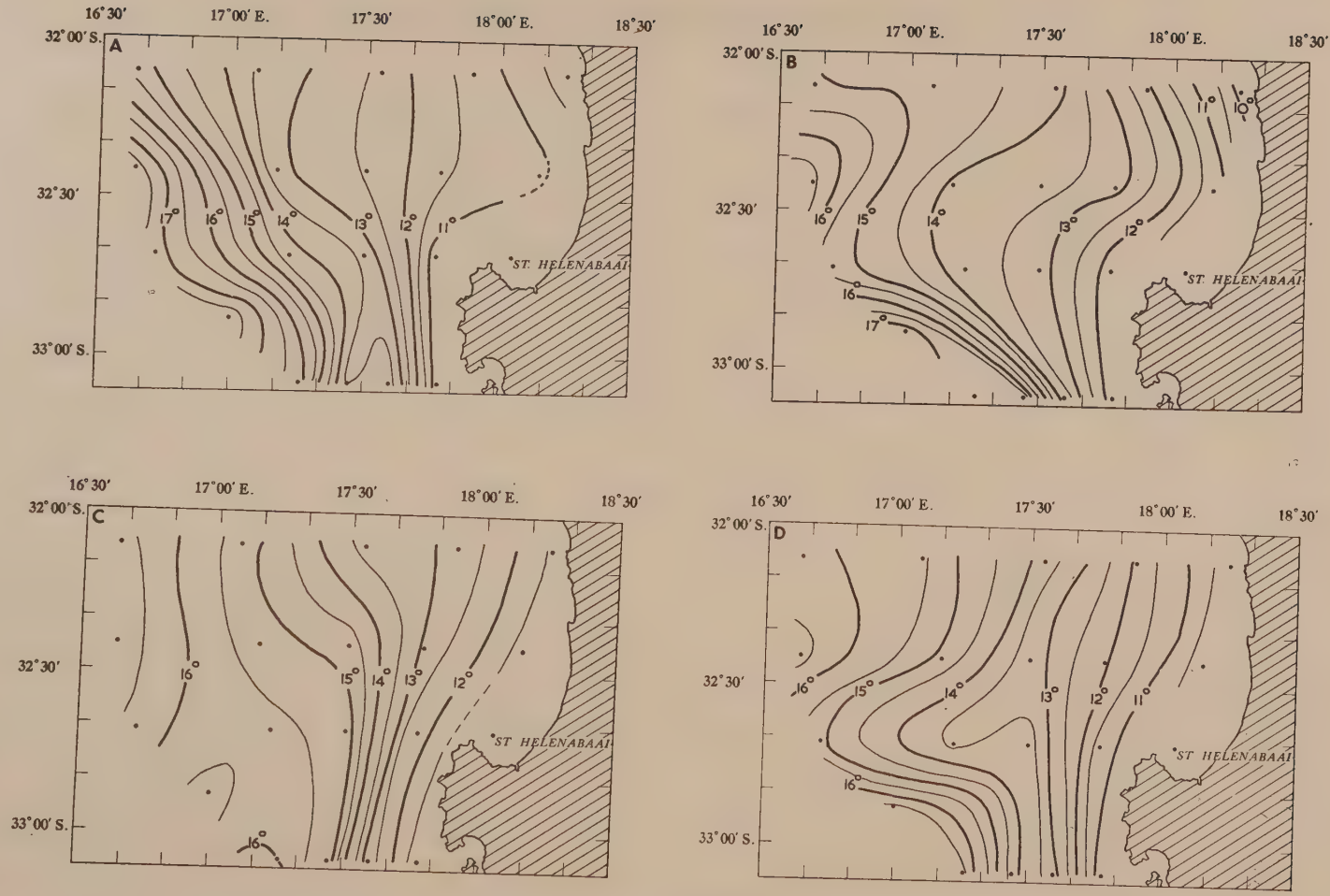

PLATE 39.—0–50 metres mean integral temperatures during March: (A) 1951, (B) 1952, (C) 1953, (D) 1954.

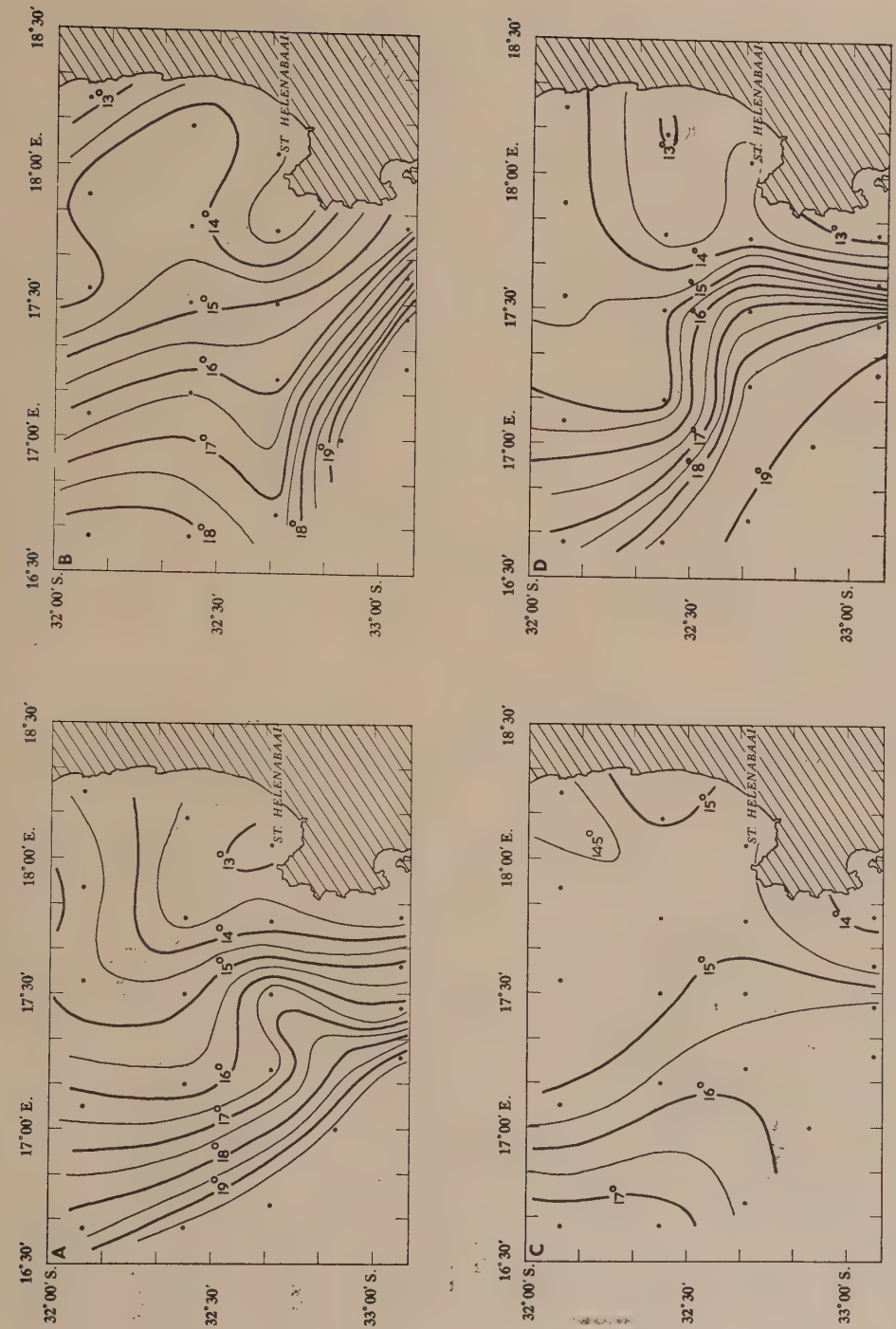

PLATE 40.—Surface temperatures during April: (A) 1951, (B) 1952, (C) 1953, (D) 1954.

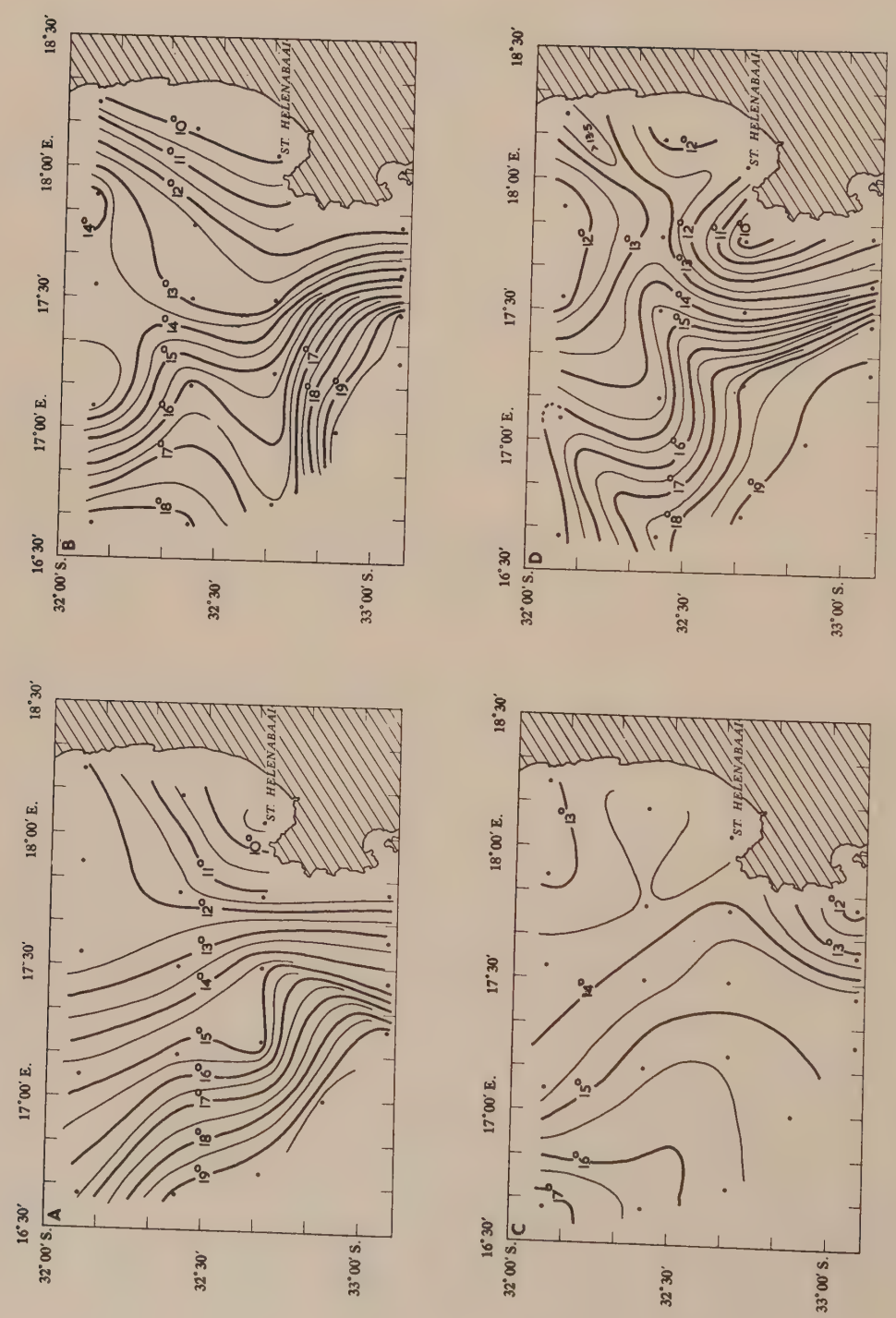

PLATE 41.—20 metres temperatures during April: (A) 1951, (B) 1952, (C) 1953, (D) 1954.

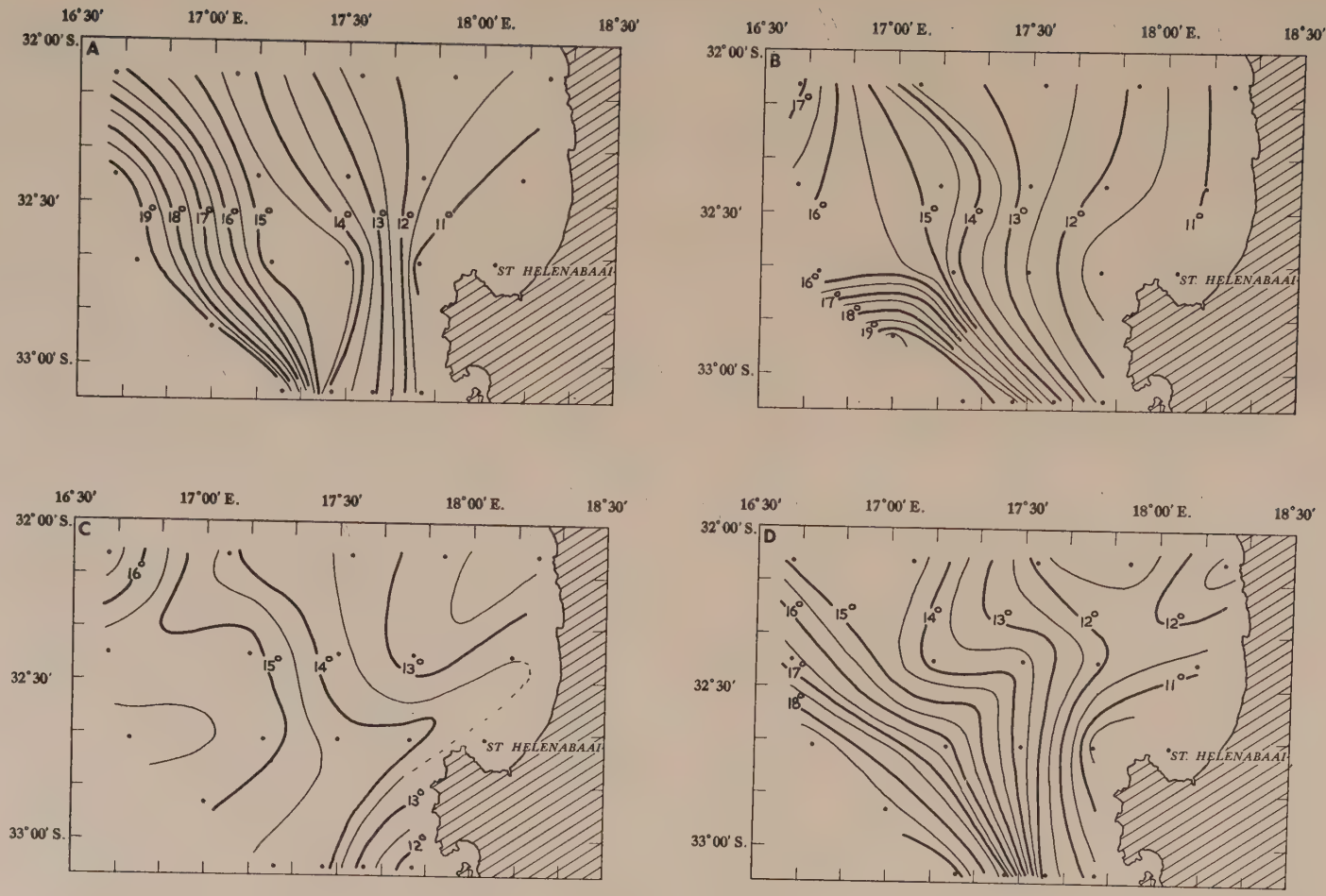

PLATE 42.—0–50 metres mean integral temperatures during April: (A) 1951, (B) 1952, (C) 1953, (D) 1954.

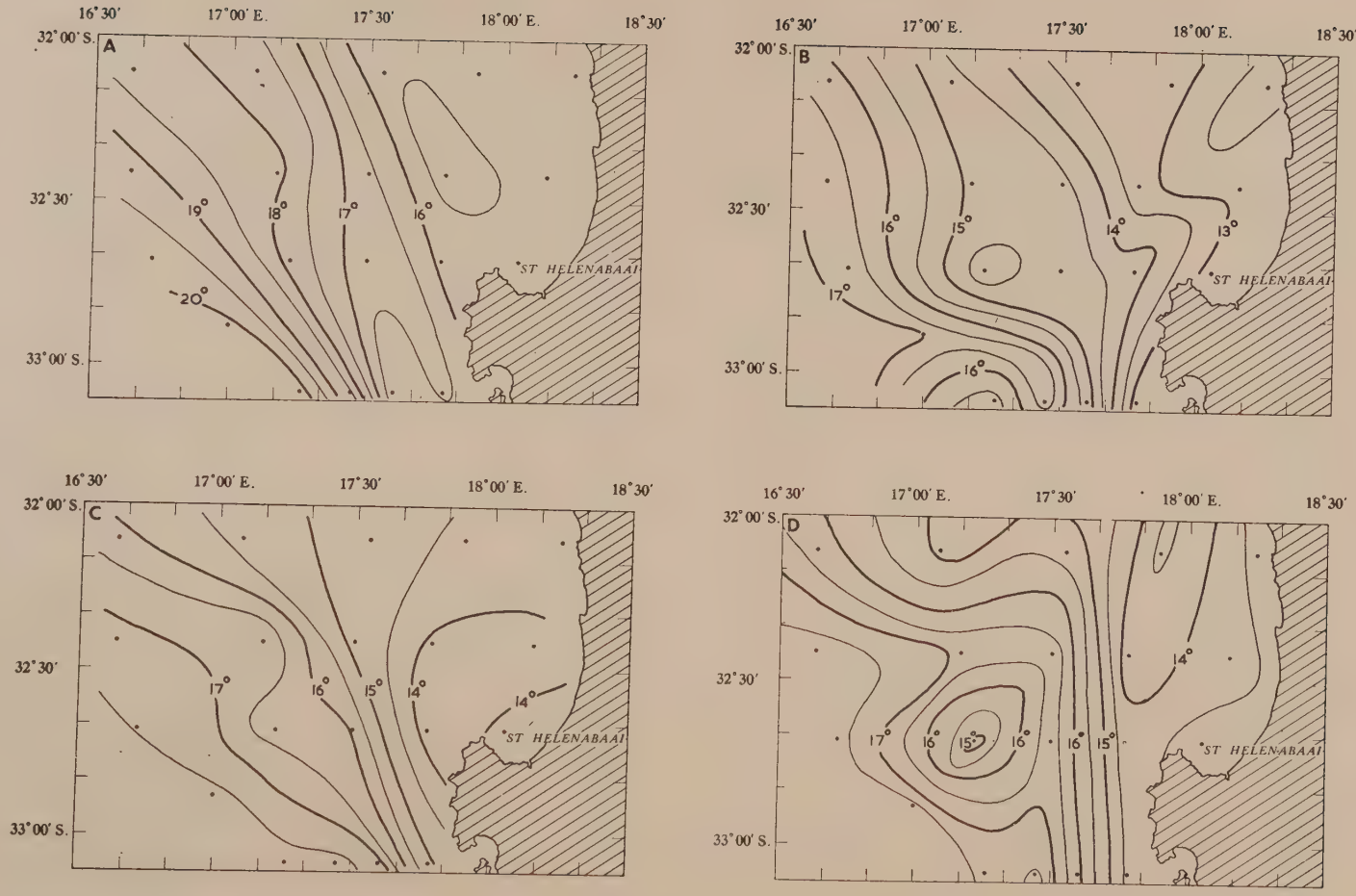

PLATE 43.—Surface temperatures during May: (A) 1951, (B) 1952, (C) 1953, (D) 1954.

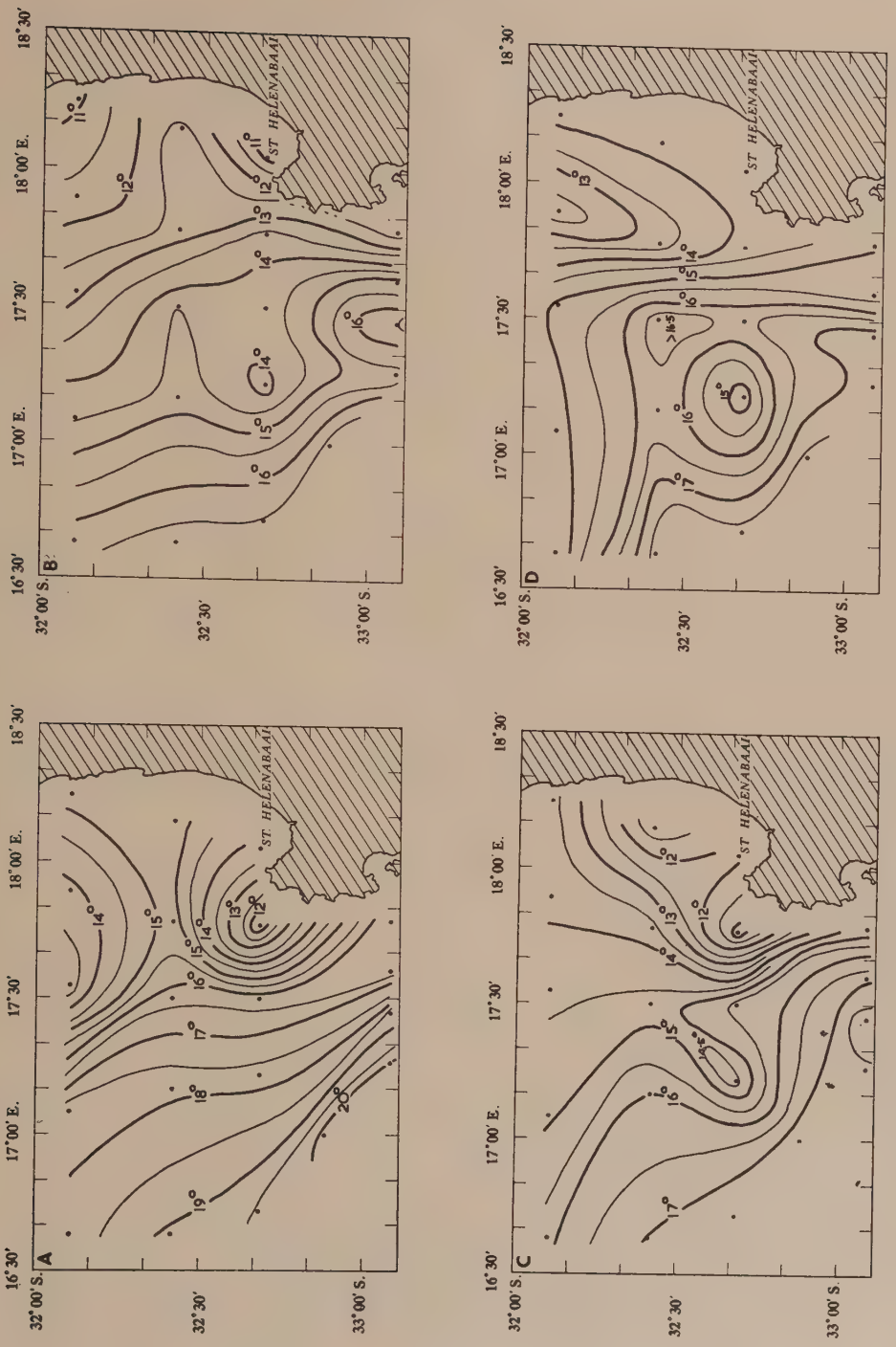

PLATE 44.—20 metres temperatures during May: (A) 1951, (B) 1952, (C) 1953, (D) 1954.

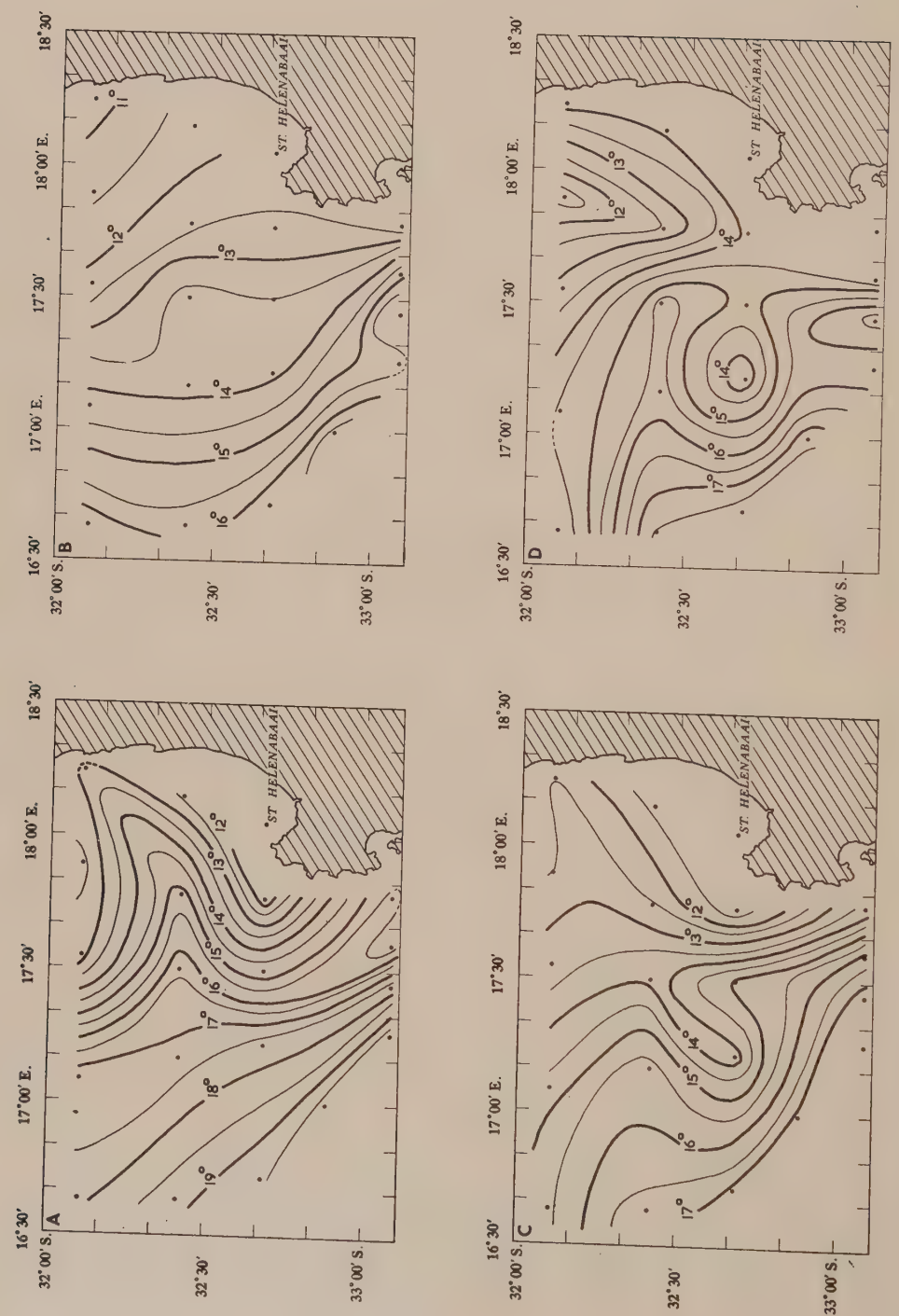

PLATE 45.—0–50 metres mean integral temperatures during May: (A) 1951, (B) 1952, (C) 1953, (D) 1954.

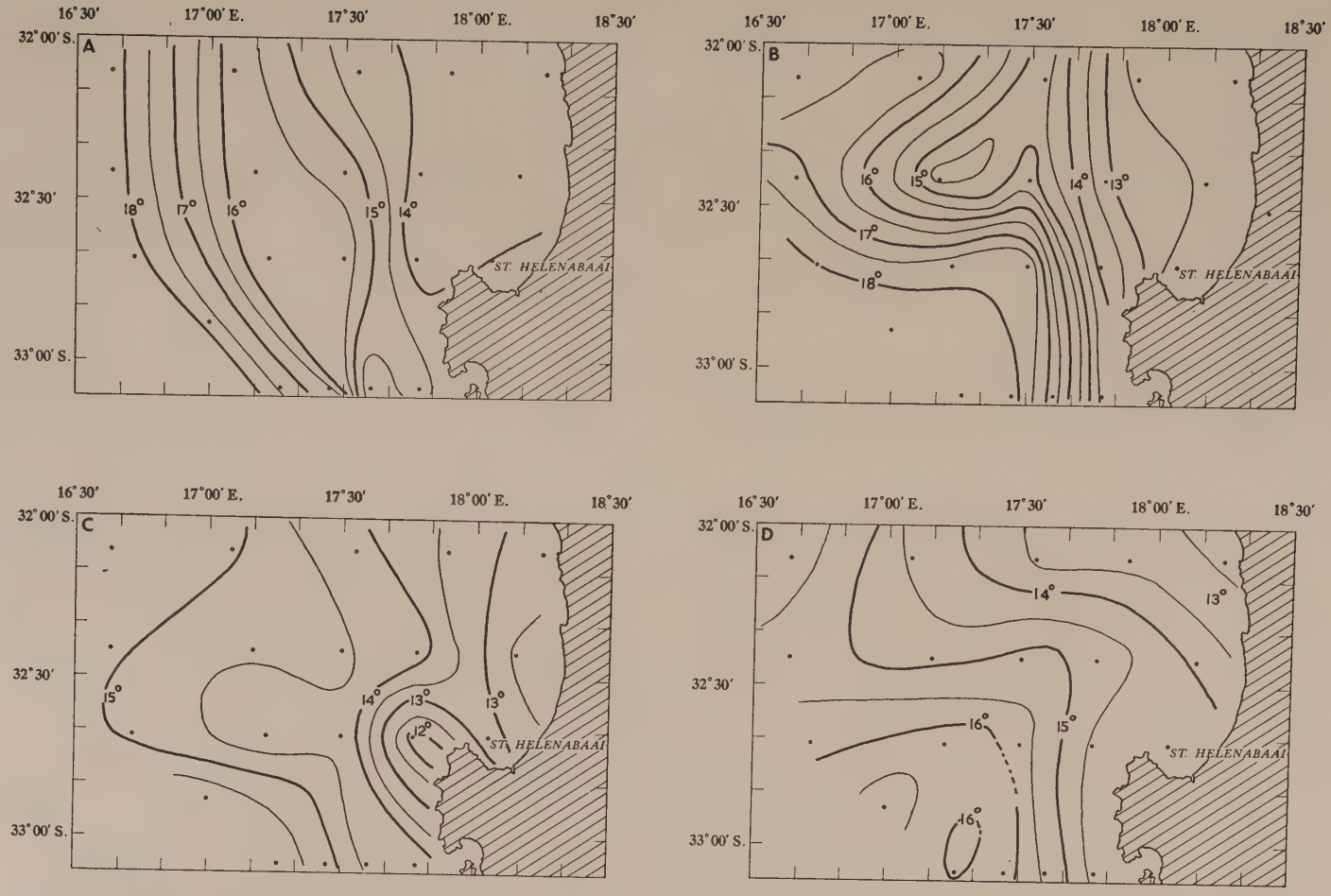

PLATE 46.—Surface temperatures during June: (A) 1951, (B) 1952, (C) 1953, (D) 1954.

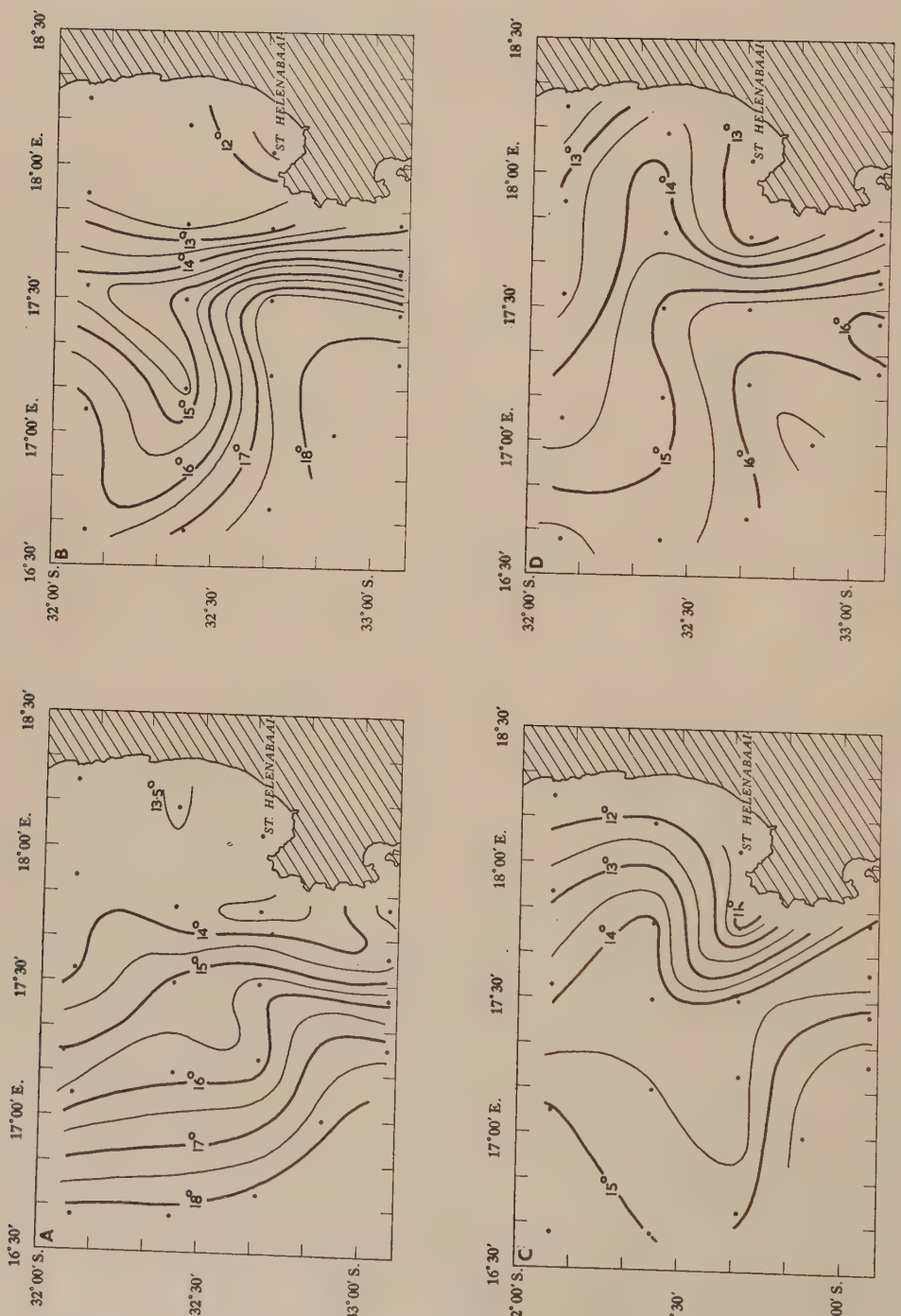

PLATE 47.—20 metres temperatures during June: (A) 1951, (B) 1952, (C) 1953, (D) 1954.

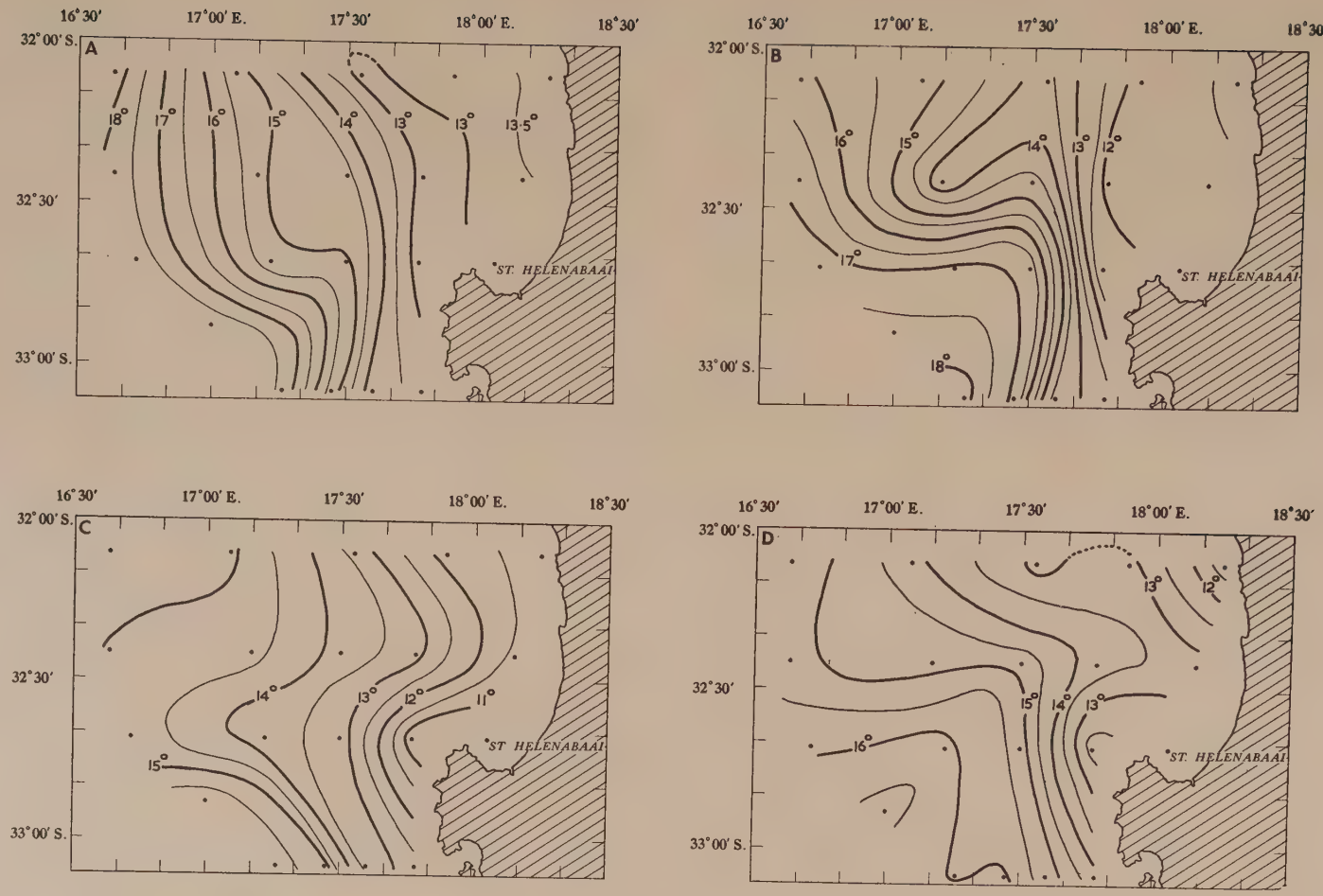

PLATE 48.—0–50 metres mean integral temperatures during June: (A) 1951, (B) 1952, (C) 1953, (D) 1954.

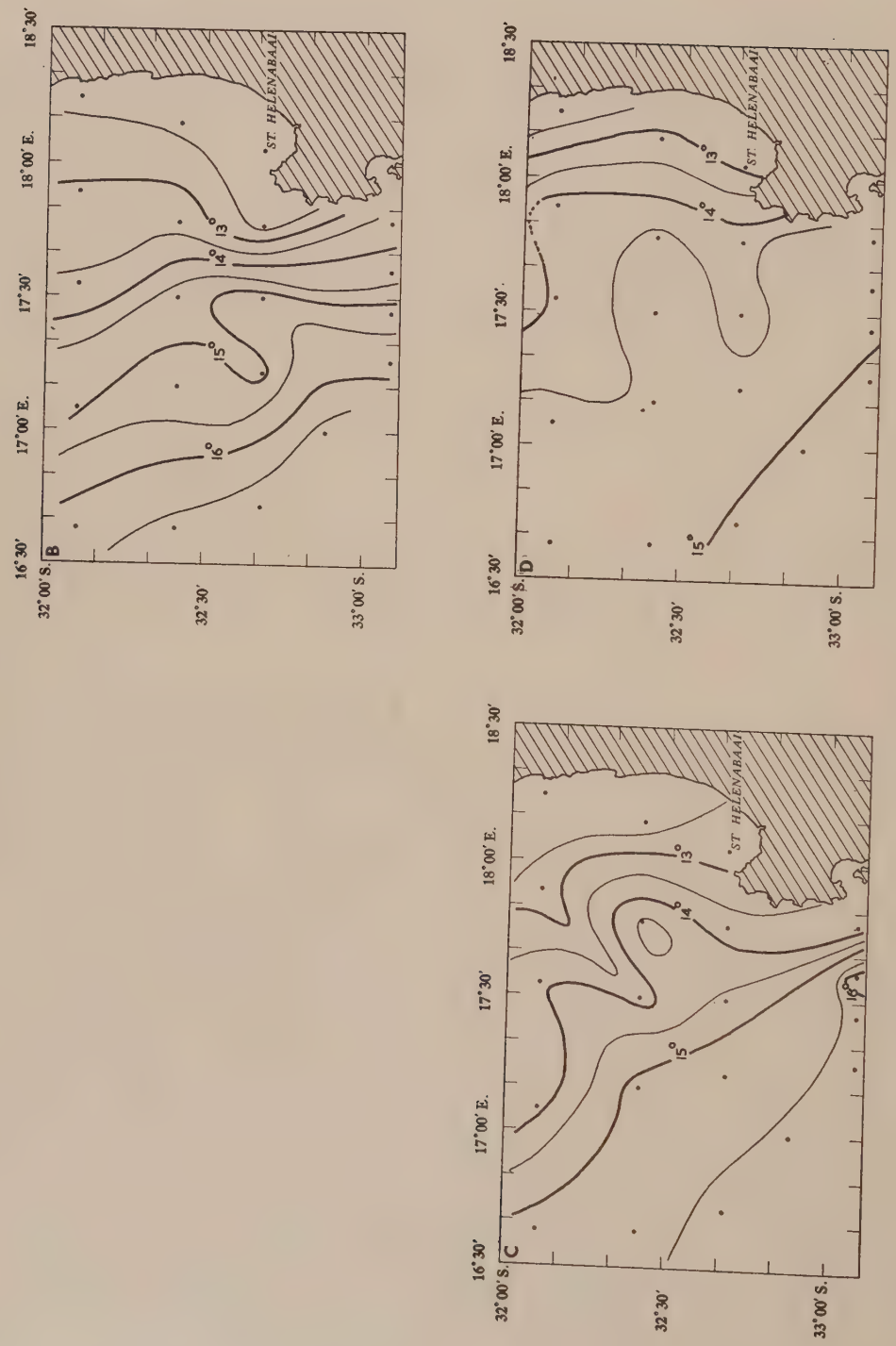

PLATE 49.—Surface temperatures during July: (A) blank, (B) 1952, (C) 1953, (D) 1954.

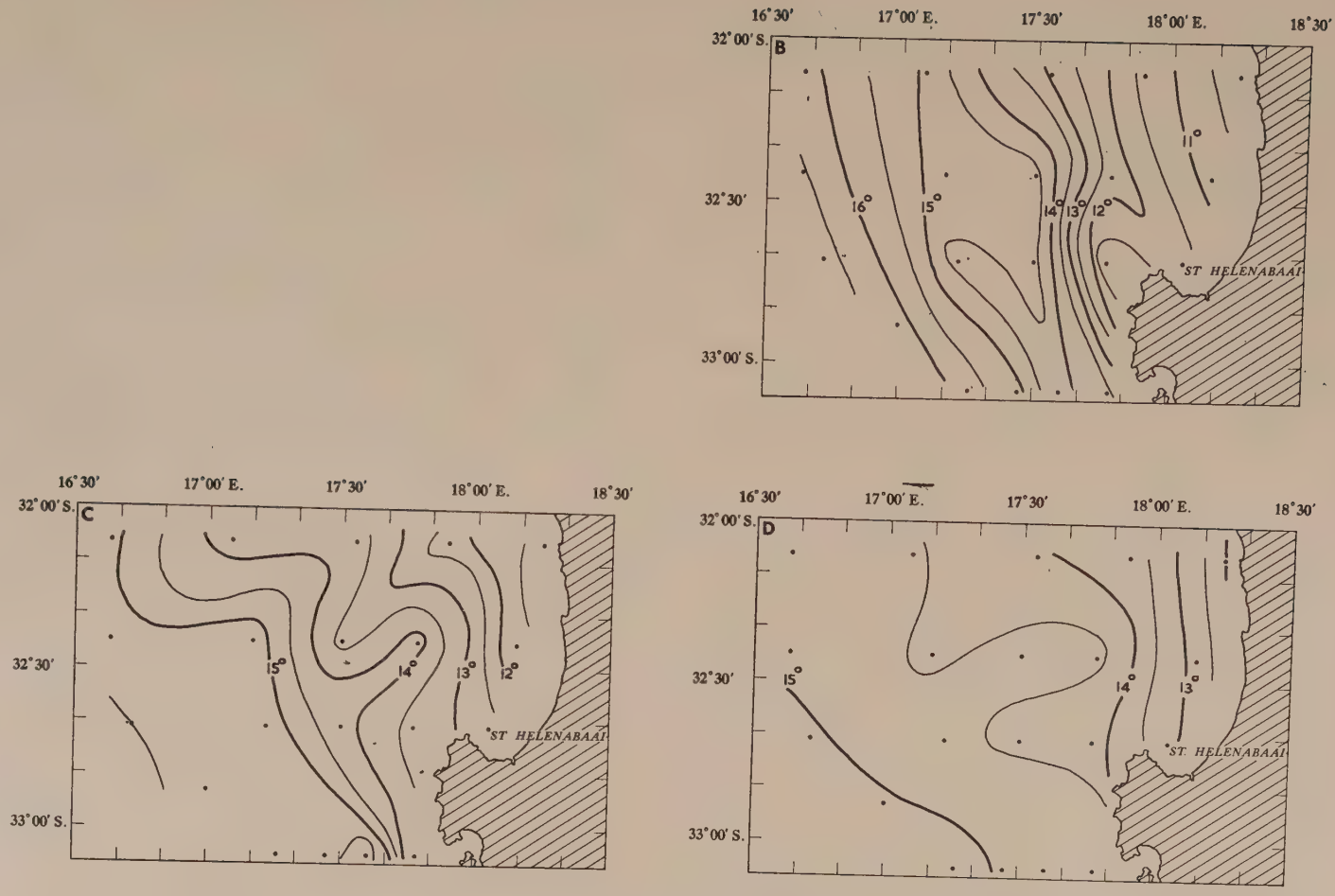

PLATE 50.—20 metres temperatures during July: (A) blank, (B) 1952, (C) 1953, (D) 1954,

Reprint from "Commerce & Industry", August, 1957

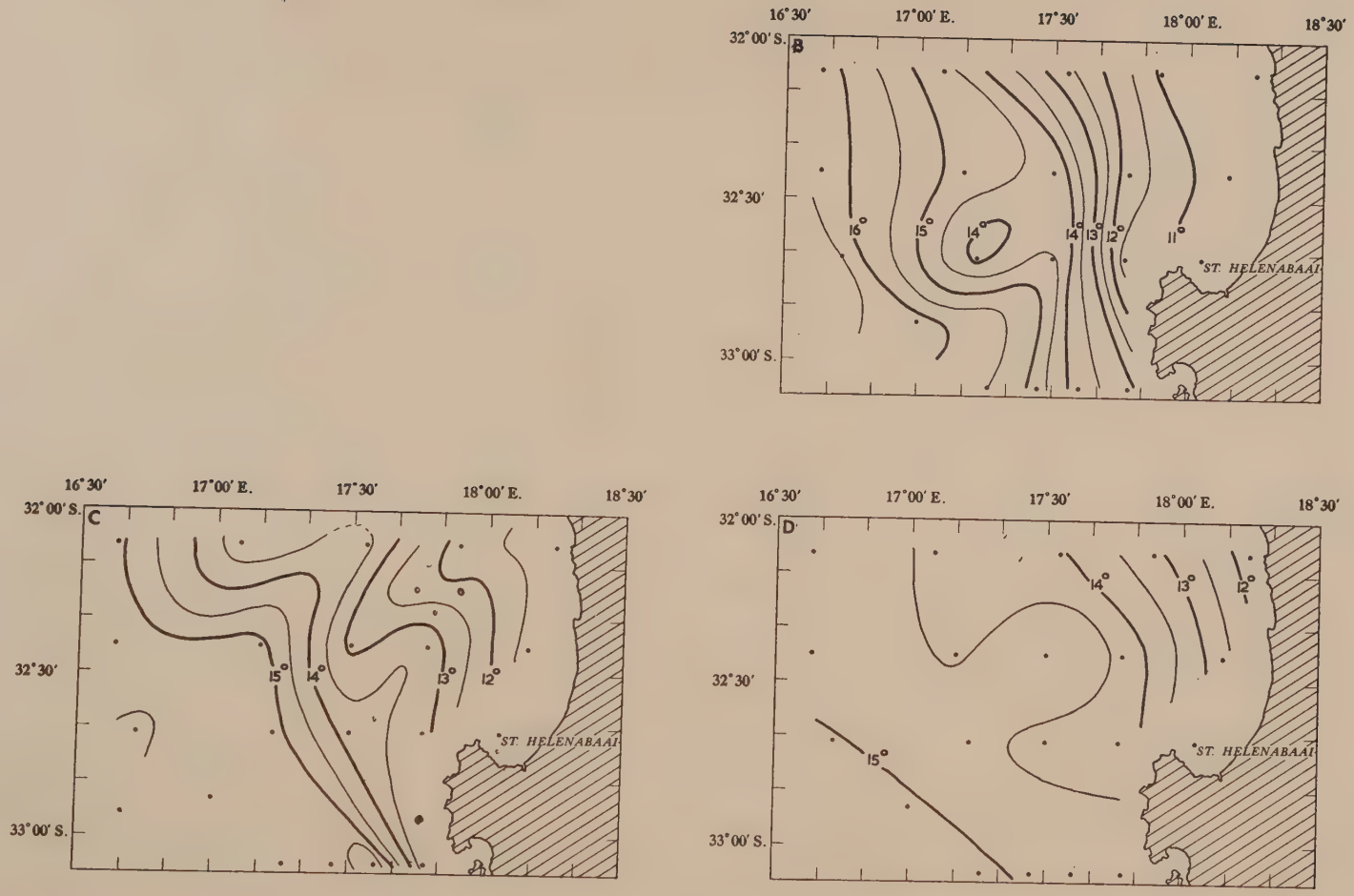

PLATE 51.—0–50 metres mean integral temperatures during July: (A) blank, (B) 1952, (C) 1953, (D) 1954.

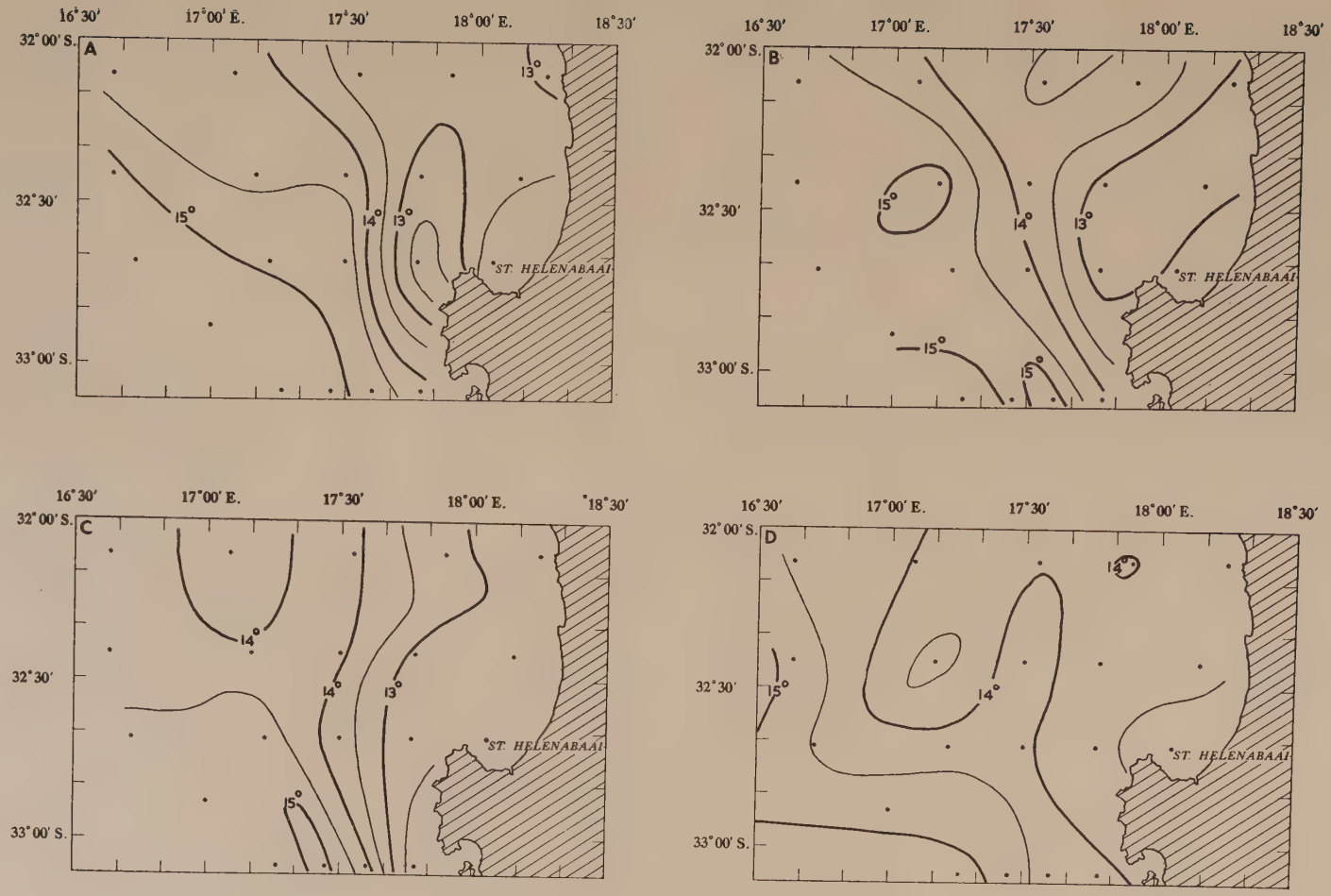

PLATE 52.—Surface temperatures during August: (A) 1951, (B) 1952, (C) 1953, (D) 1954.

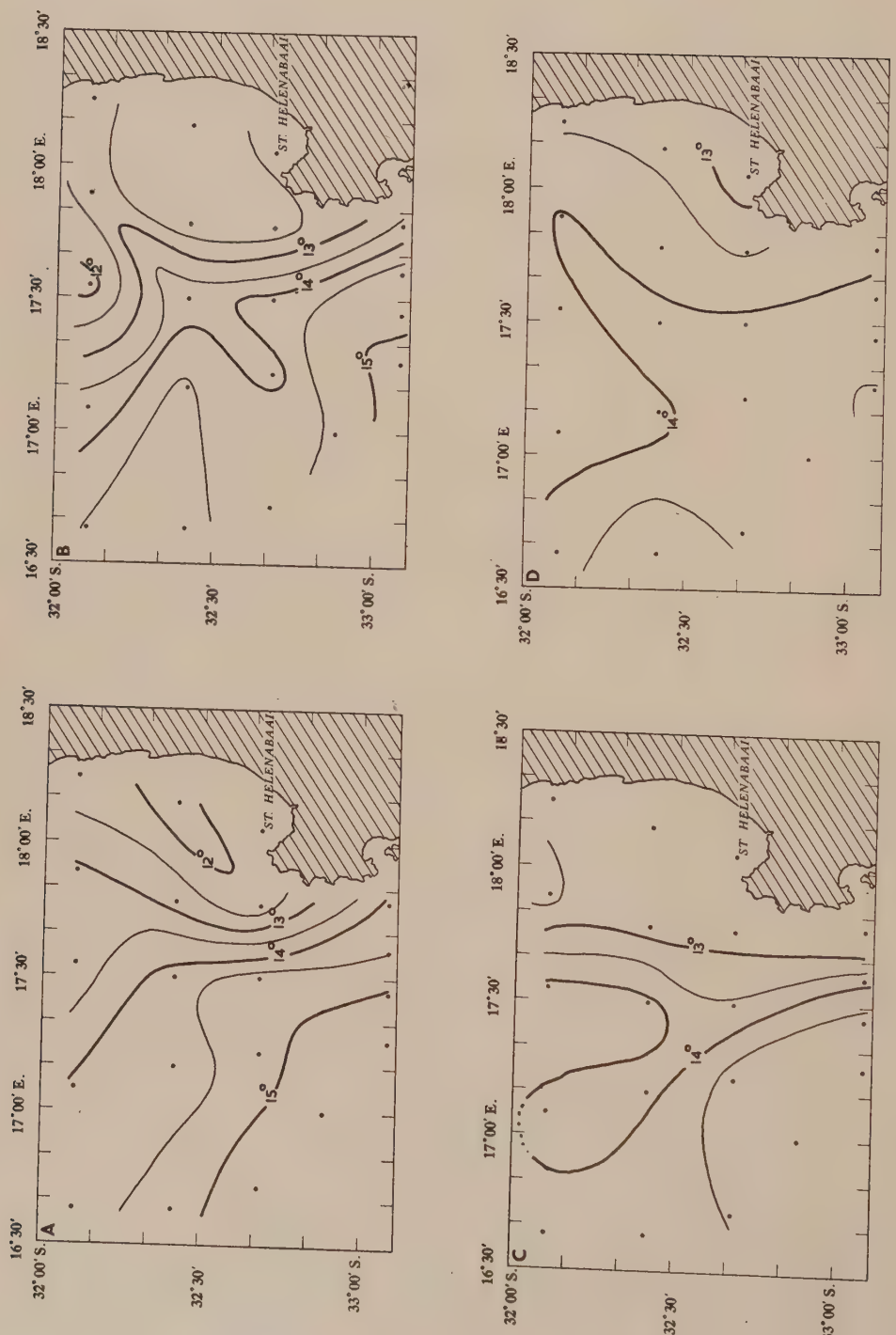

PLATE 53.—20 metres temperatures during August: (A) 1951, (B) 1952, (C) 1953, (D) 1954.

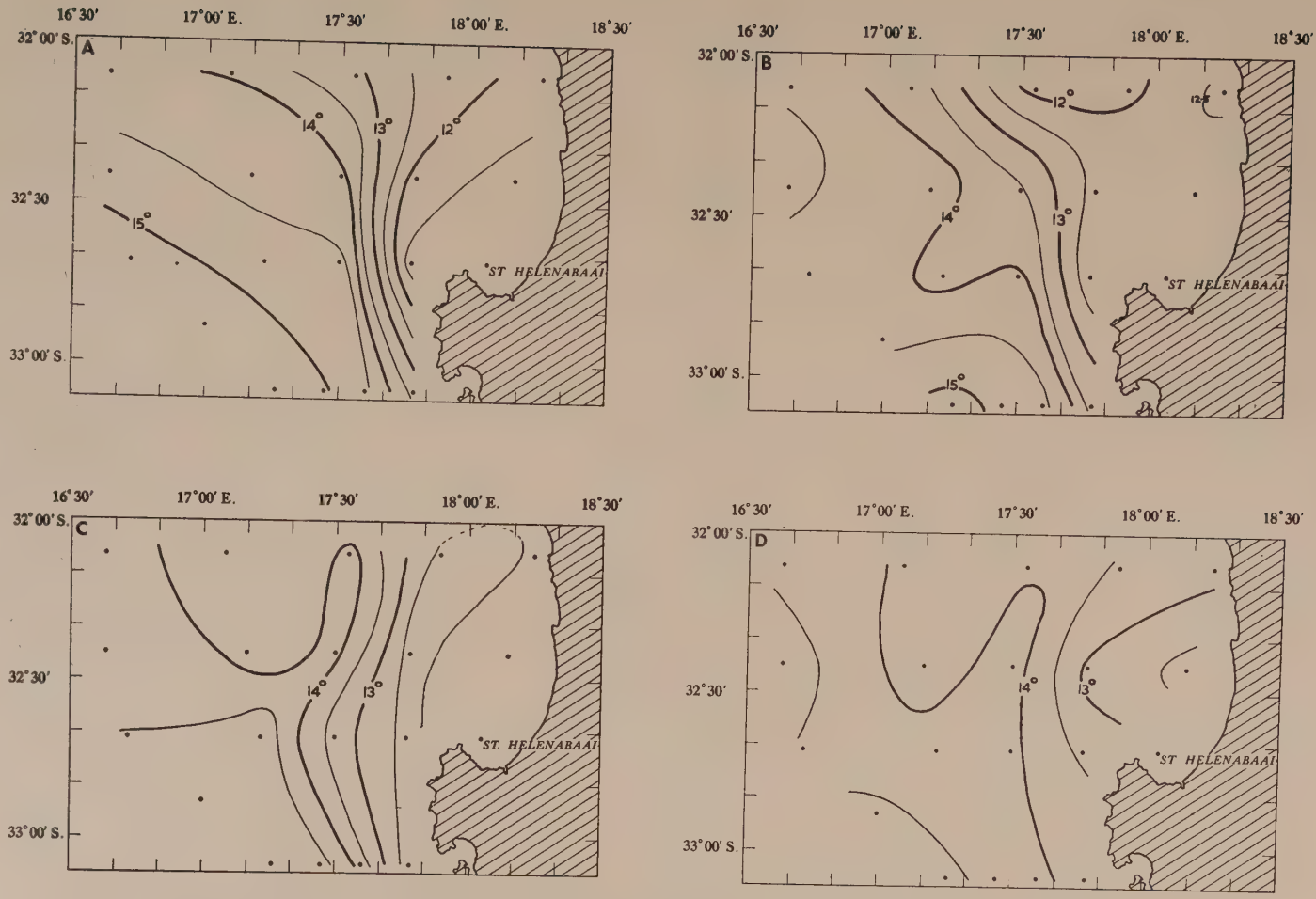

PLATE 54.—0–50 metres mean integral temperatures durings August: (A) 1951, (B) 1952, (C) 1953, (D) 1954.

Reprint from "Commerce & Industry", August, 1957

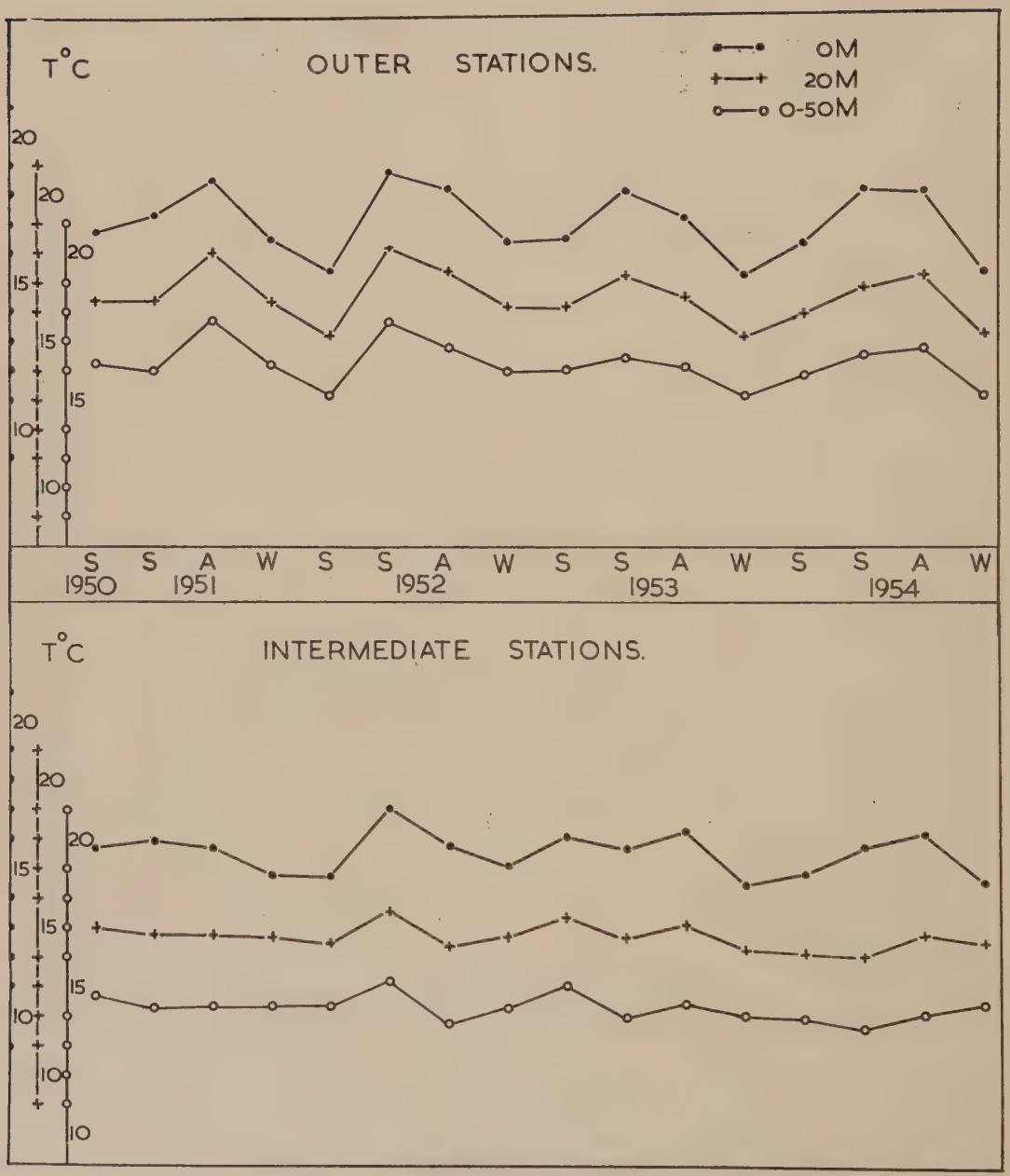

PLATE 55.—Seasonal variation of surface, 20 metres and 0–50 metres mean integral temperatures, outer and intermediate stations, Spring, 1950—Winter, 1954.

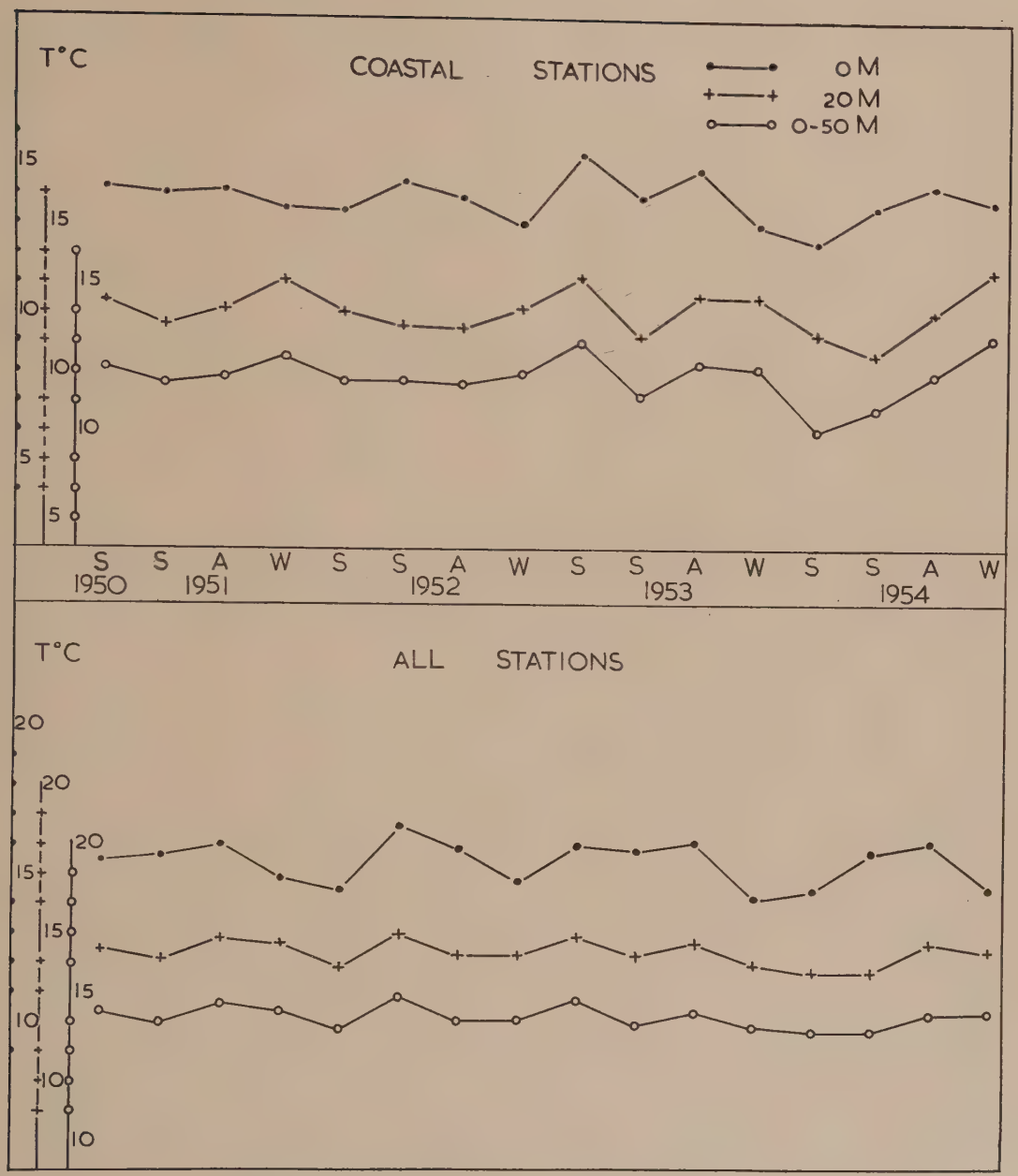

PLATE 56.—Seasonal variation of surface, 20 metres and 0–50 metres mean integral temperatures, coastal and all stations, Spring, 1950—Winter, 1954.

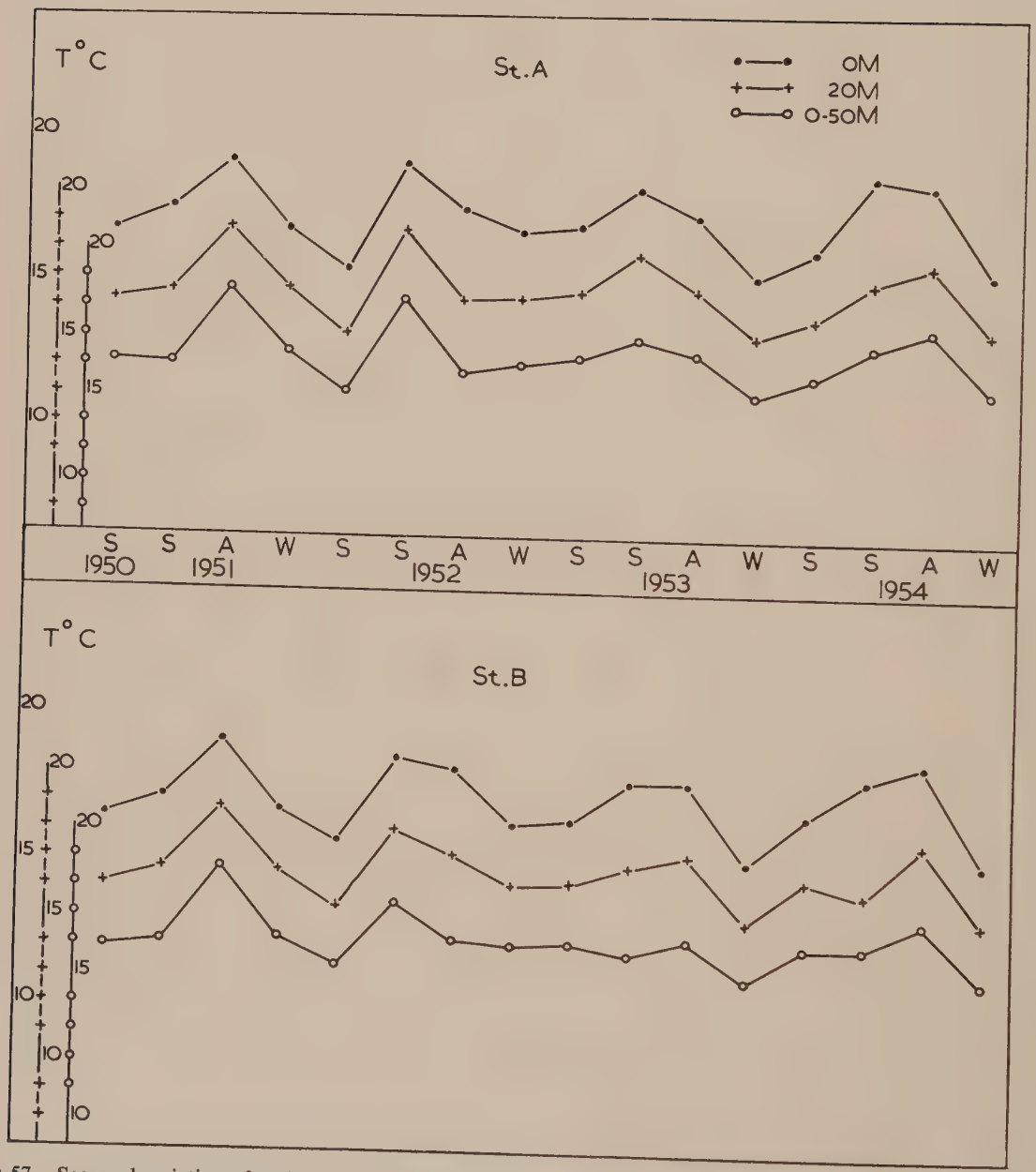

PLATE 57.—Seasonal variation of surfaces, 20 metre and 0–50 metres mean integral temperatures, individual stations, Spring, 1950—Winter, 1954.

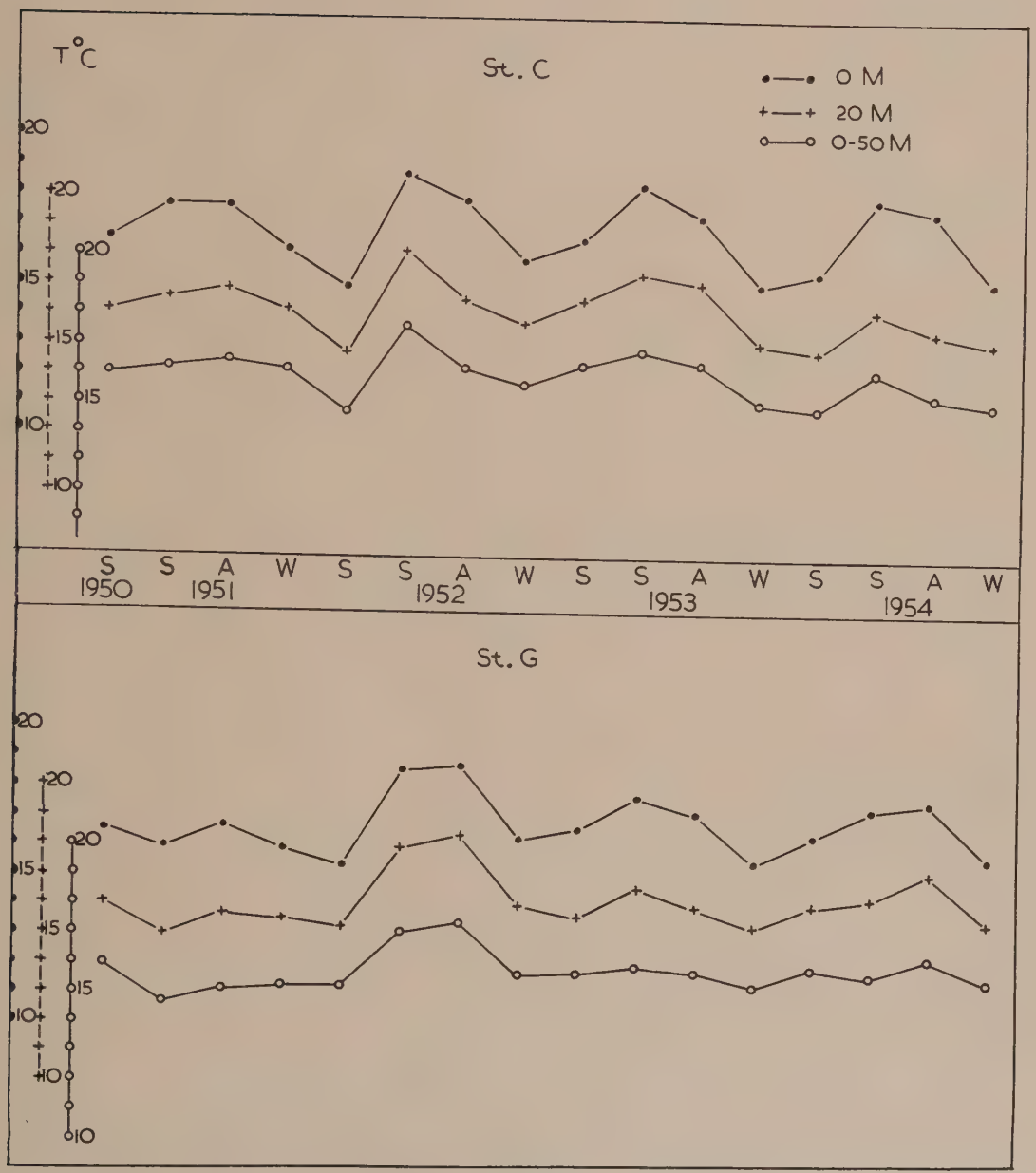

PLATE 58.—Seasonal variation of surface, 20 metres and 0–50 metres mean integral temperatures, individual stations, Spring, 1950—Winter, 1954.

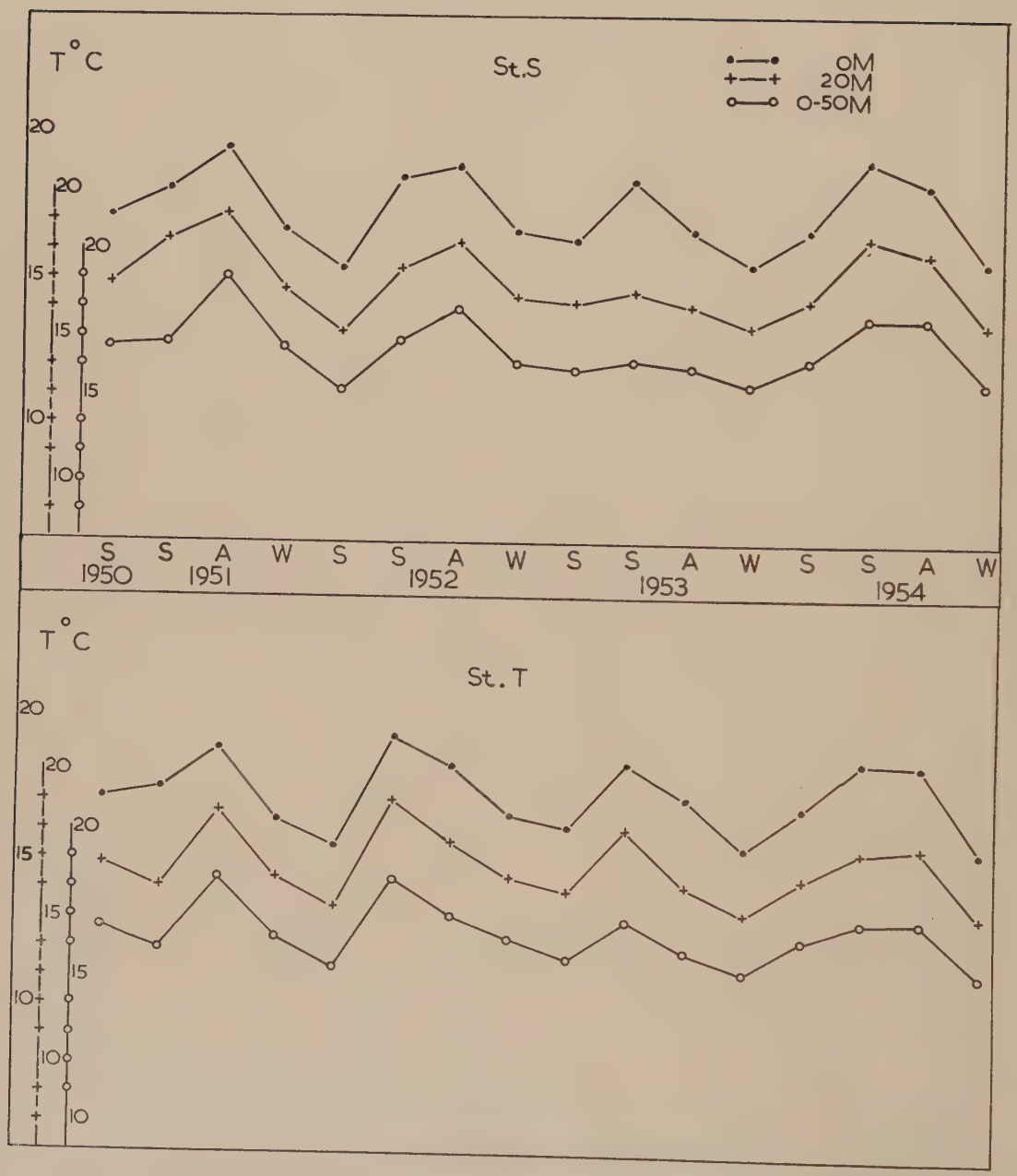

PLATE 59.—Seasonal variation of surface, 20 metres and 0–50 metres mean integral temperatures, individual stations, Spring, 1950—Winter, 1954.

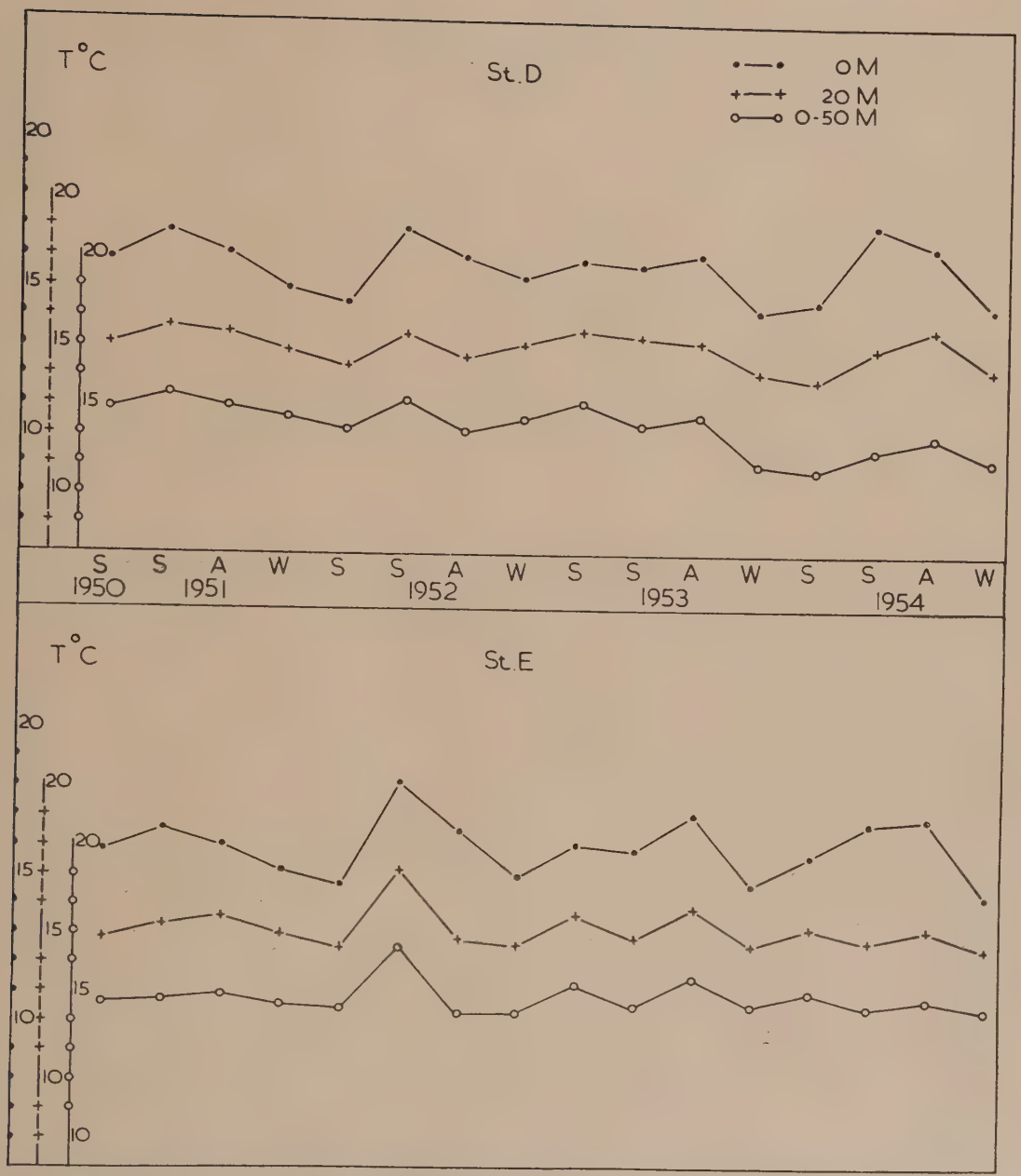

PLATE 60.—Seasonal variation of surface, 20 metres and 0–50 metres mean integral temperatures, individual stations, Spring, 1950—Winter, 1954.

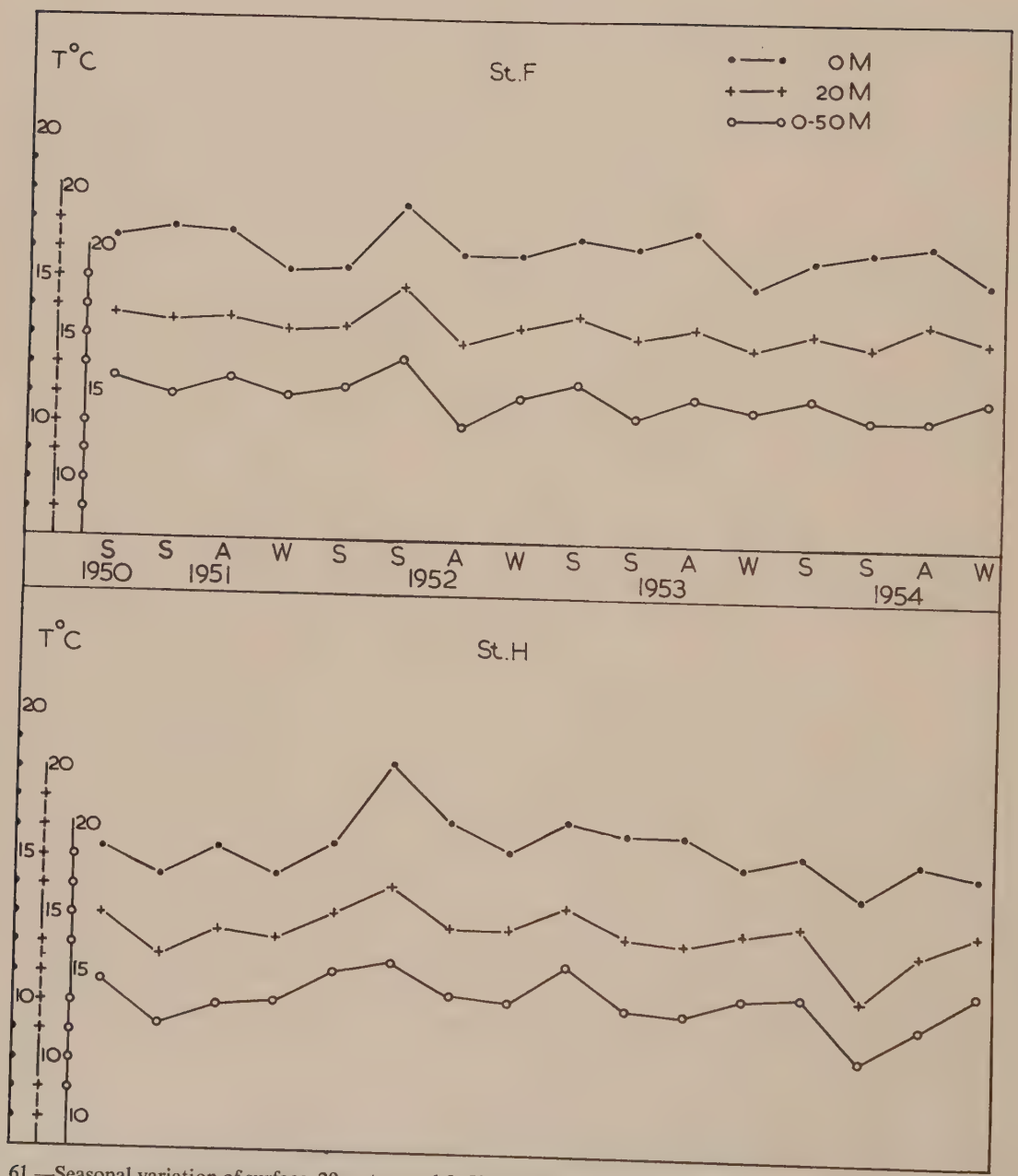

PLATE 61.—Seasonal variation of surface, 20 metres and 0–50 metres mean integral temperatures, individual stations, Spring, 1950—Winter, 1954.

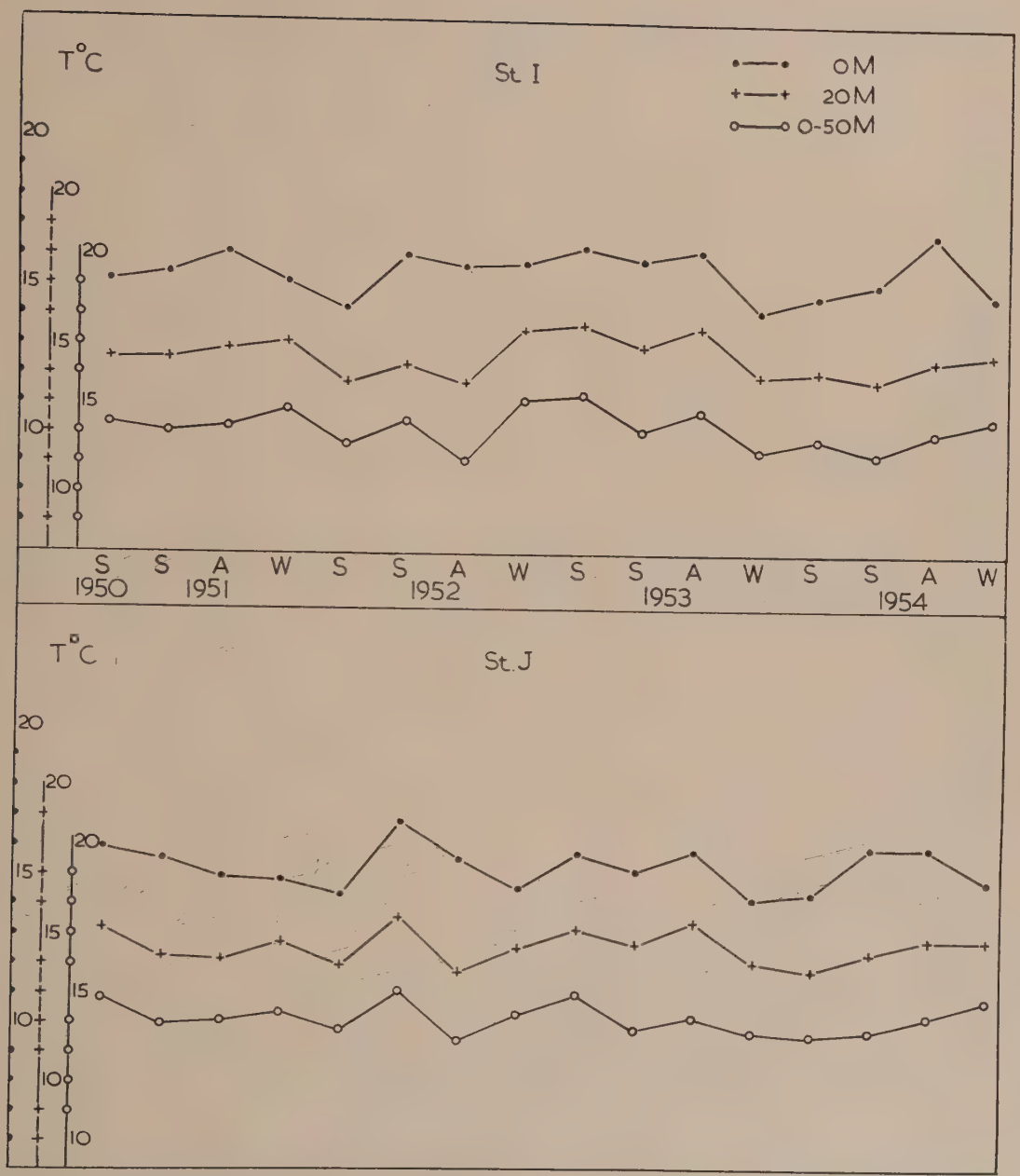

PLATE 62.—Seasonal variation of surface, 20 metres and 0–50 metres mean integral temperatures, individual stations, Spring, 1950—Winter, 1954.

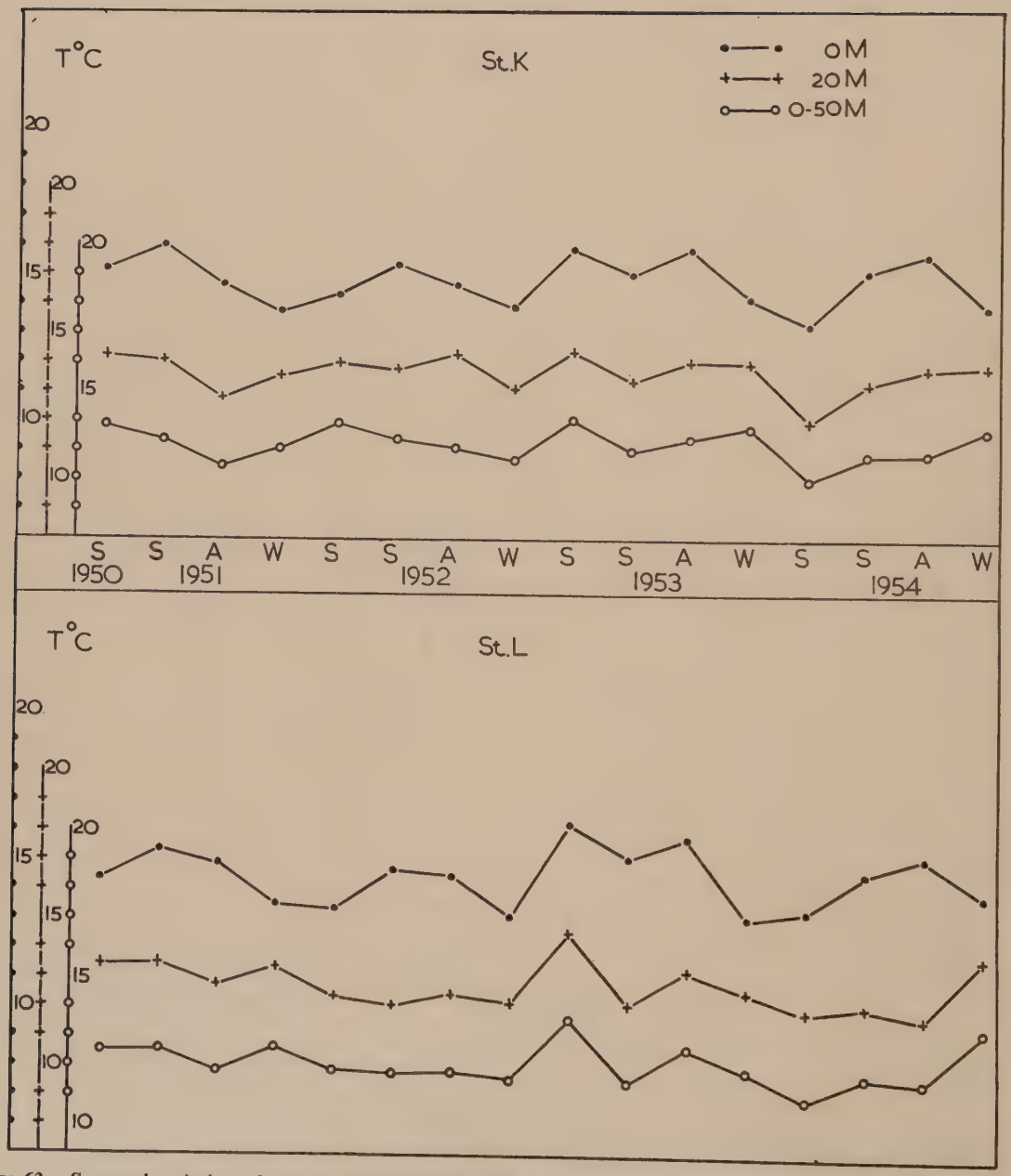

PLATE 63.—Seasonal variation of surface, 20 metres and 0–50 metres mean integral temperatures, individual stations, Spring, 1950—Winter, 1954.

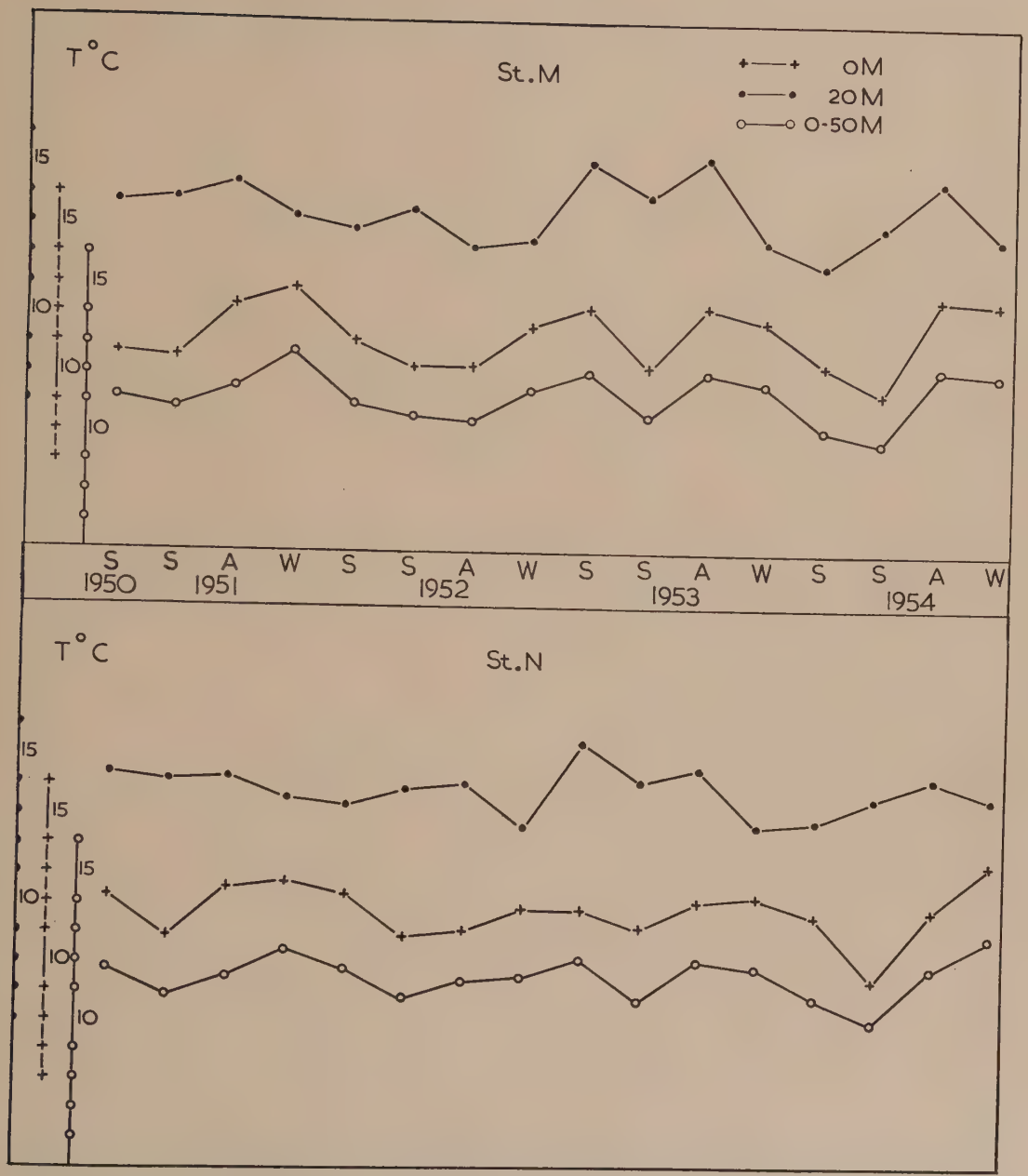

PLATE 64.—Seasonal variation of surface, 20 metres and 0–50 metres mean integral temperatures, individual stations, Spring,1950—Winter, 1954.

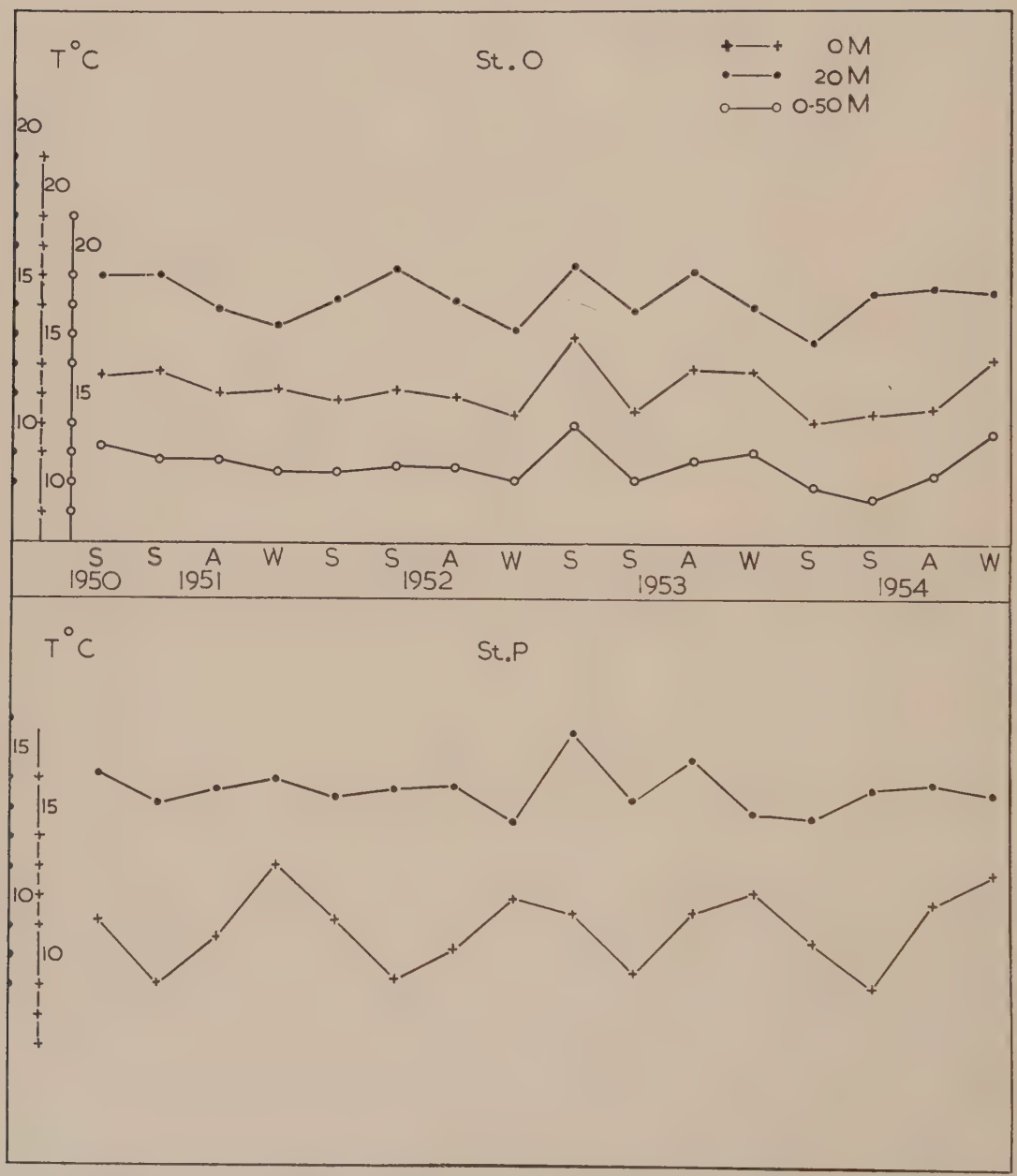

PLATE 65.—Seasonal variation of surface, 20 metres and 0–50 metres mean integral temperatures, individual stations, Spring, 1950—Winter, 1954.

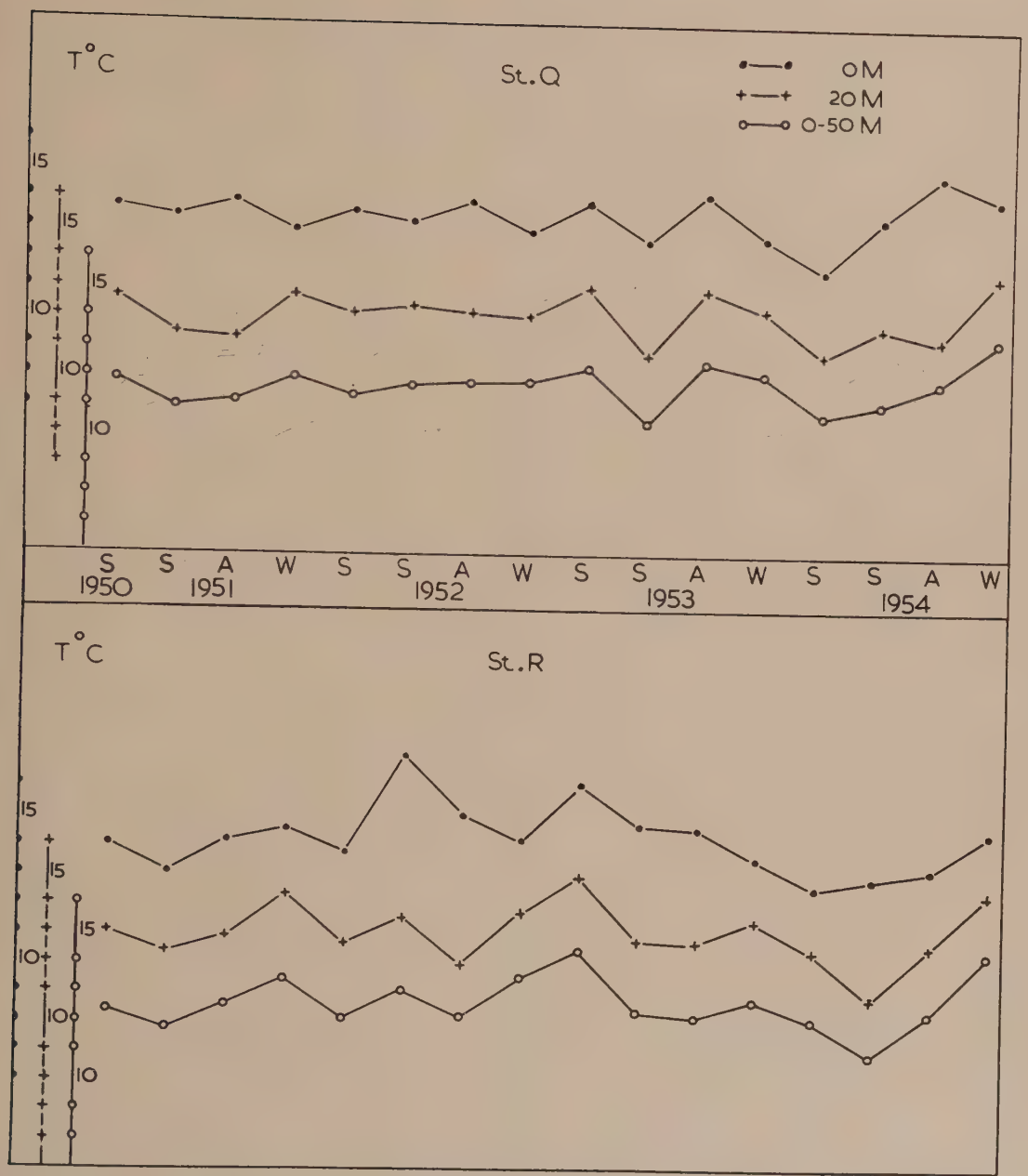

PLATE 66.—Seasonal variation of surface, 20 metres and 0–50 metres mean integral temperatures, individual stations, Spring, 1950—Winter, 1954.

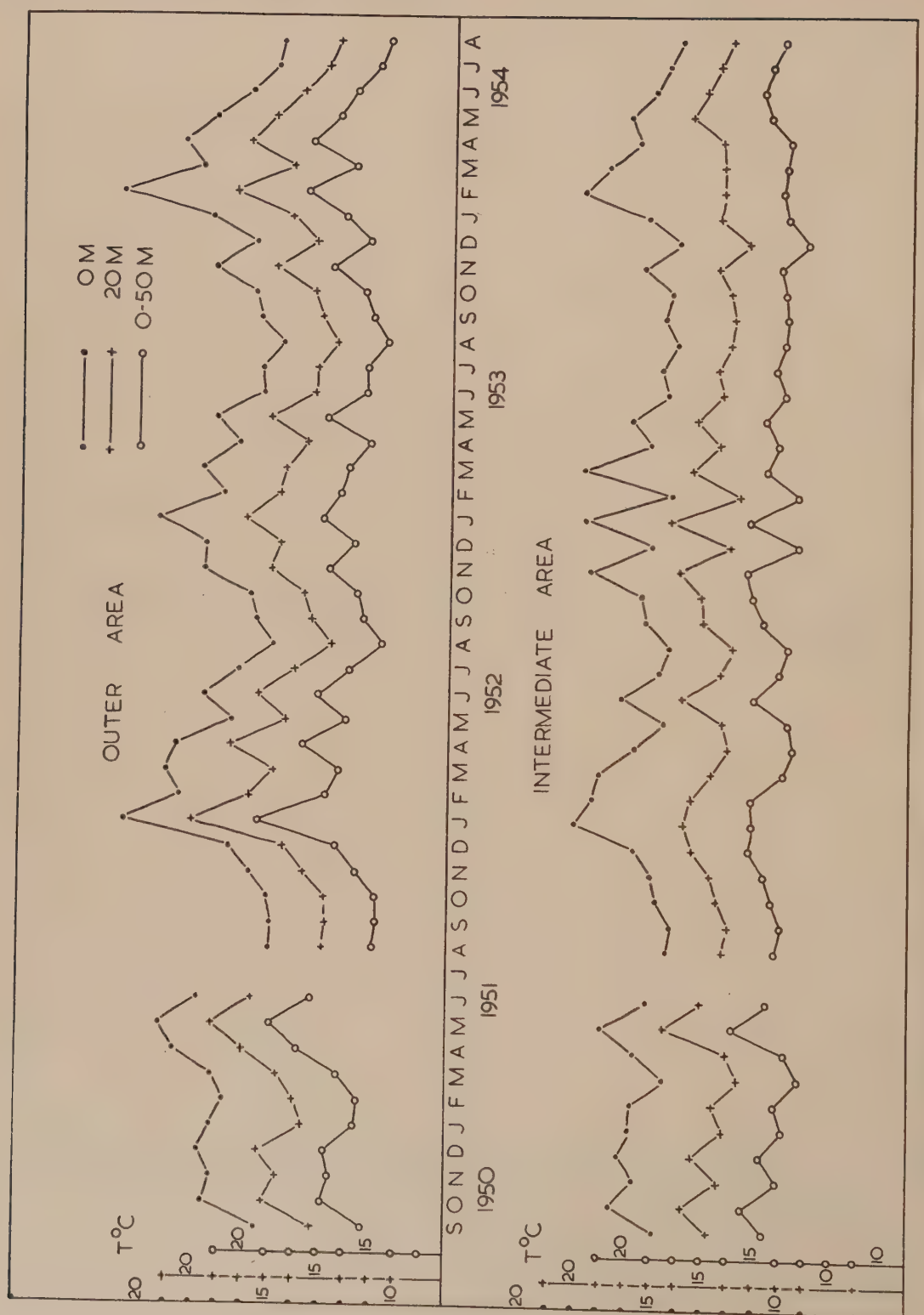

PLATE 67.—Monthly variation of surface, 20 metres and 0–50 metres mean integral temperatures, September, 1950—August, 1954.

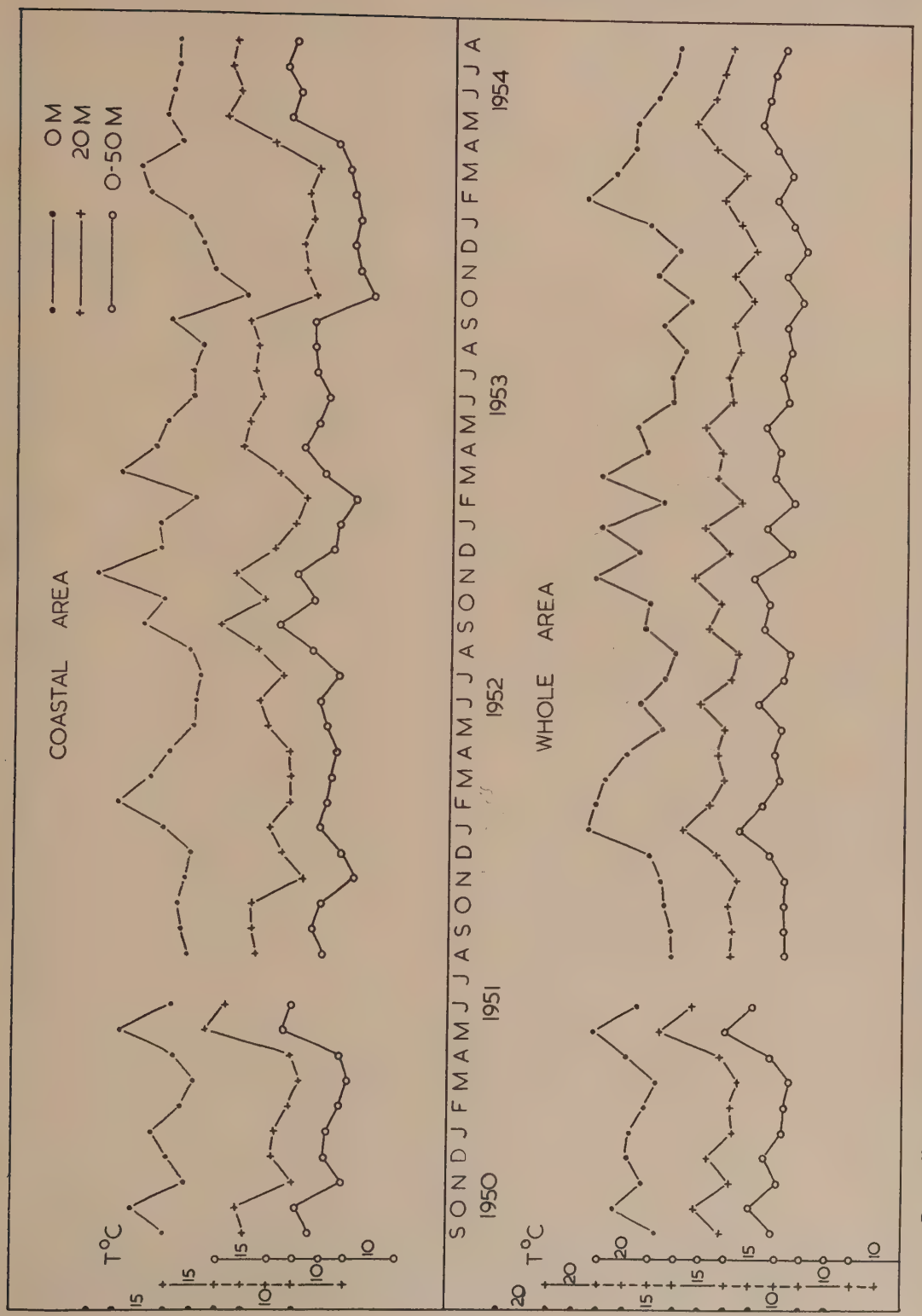

PLATE 68.—Monthly variation of surface, 20 metres and 0–50 metres mean integral temperatures, September, 1950—August, 1954.

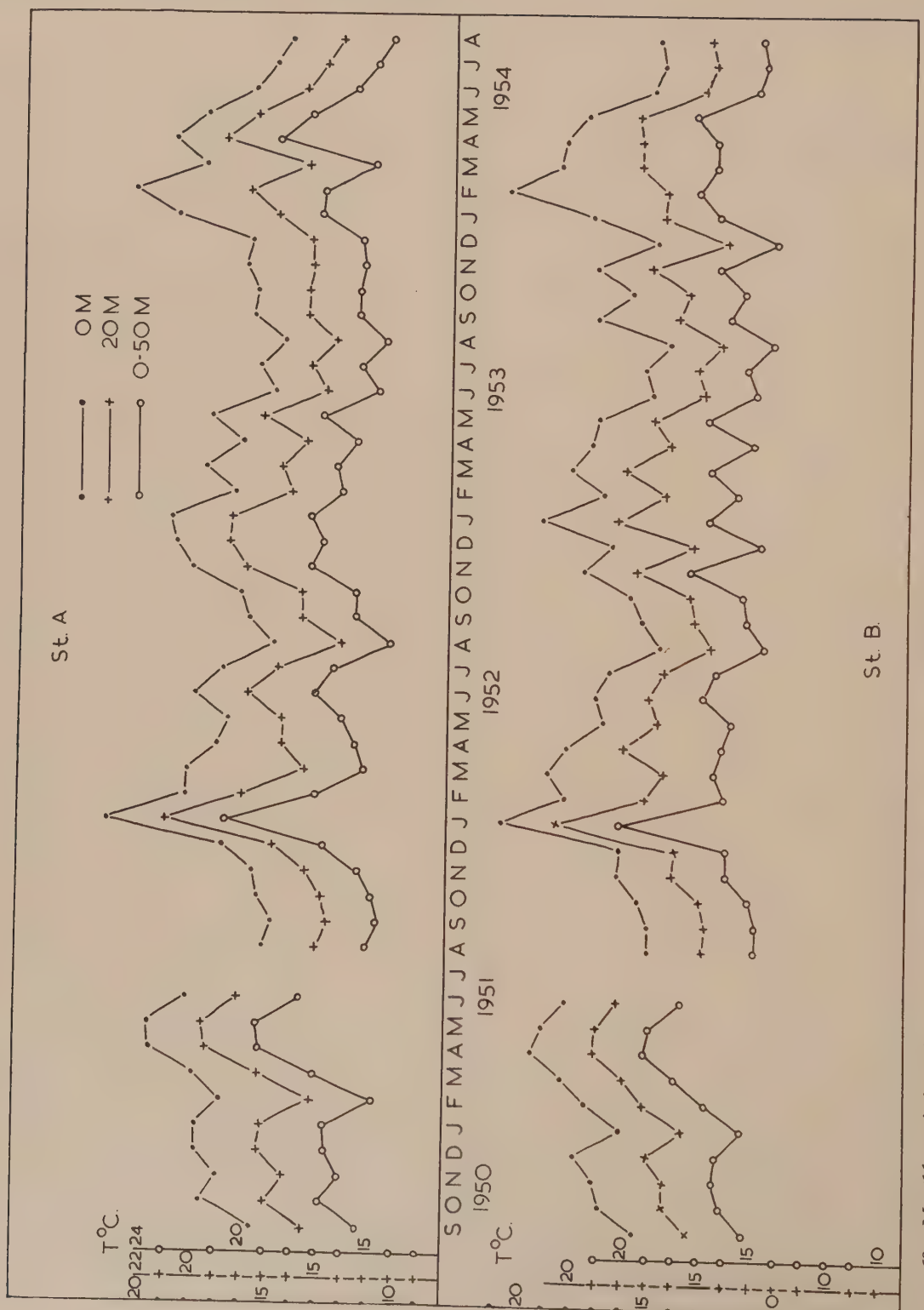

PLATE 69.—Monthly variation of surface, 20 metres and 0–50 metres mean integral temperatures at individual stations September, 1950—August, 1954.

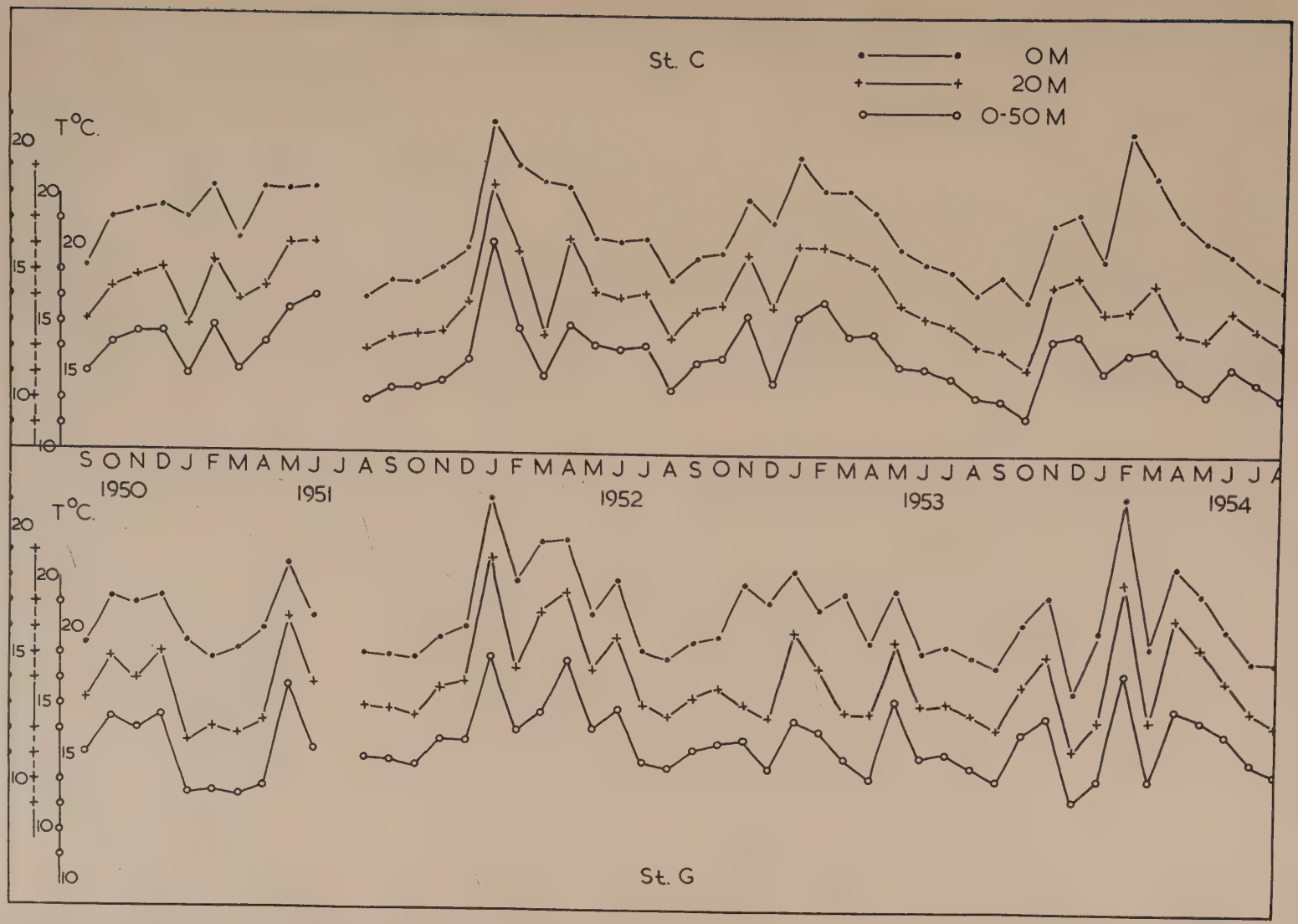

PLATE 70.—Monthly variation of surface, 20 metres and 0–50 metres mean integral temperatures at individual stations, September, 1950—August, 1954.

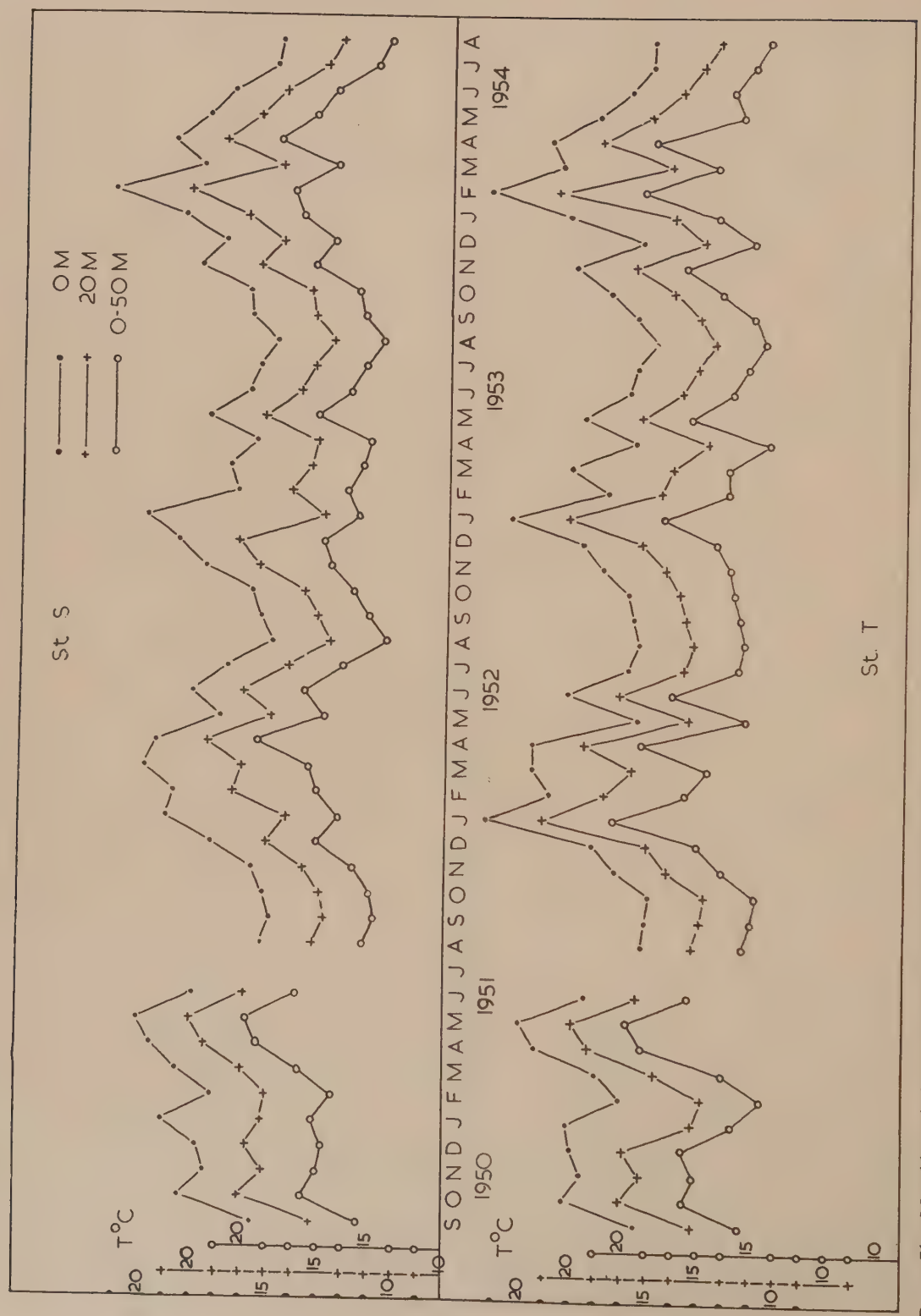

PLATE 71.—Monthly variation of surface, 20 metres and 0–50 metres mean integral temperatures at individual stations, September, 1950—August, 1954.

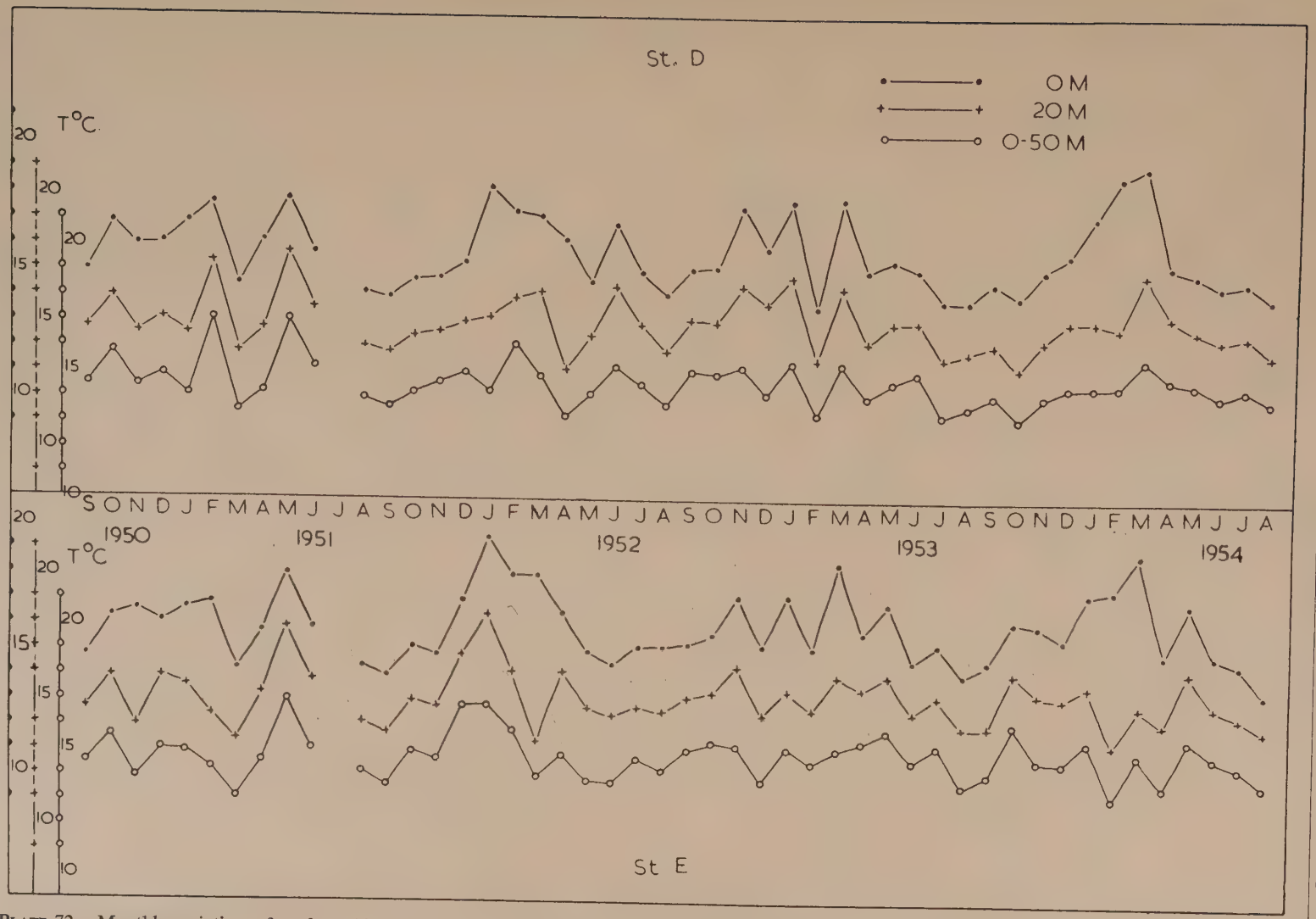

PLATE 72.—Monthly variation of surface, 20 metres and 0–50 metres mean integral temperatures at individual stations, September, 1950—August, 1954

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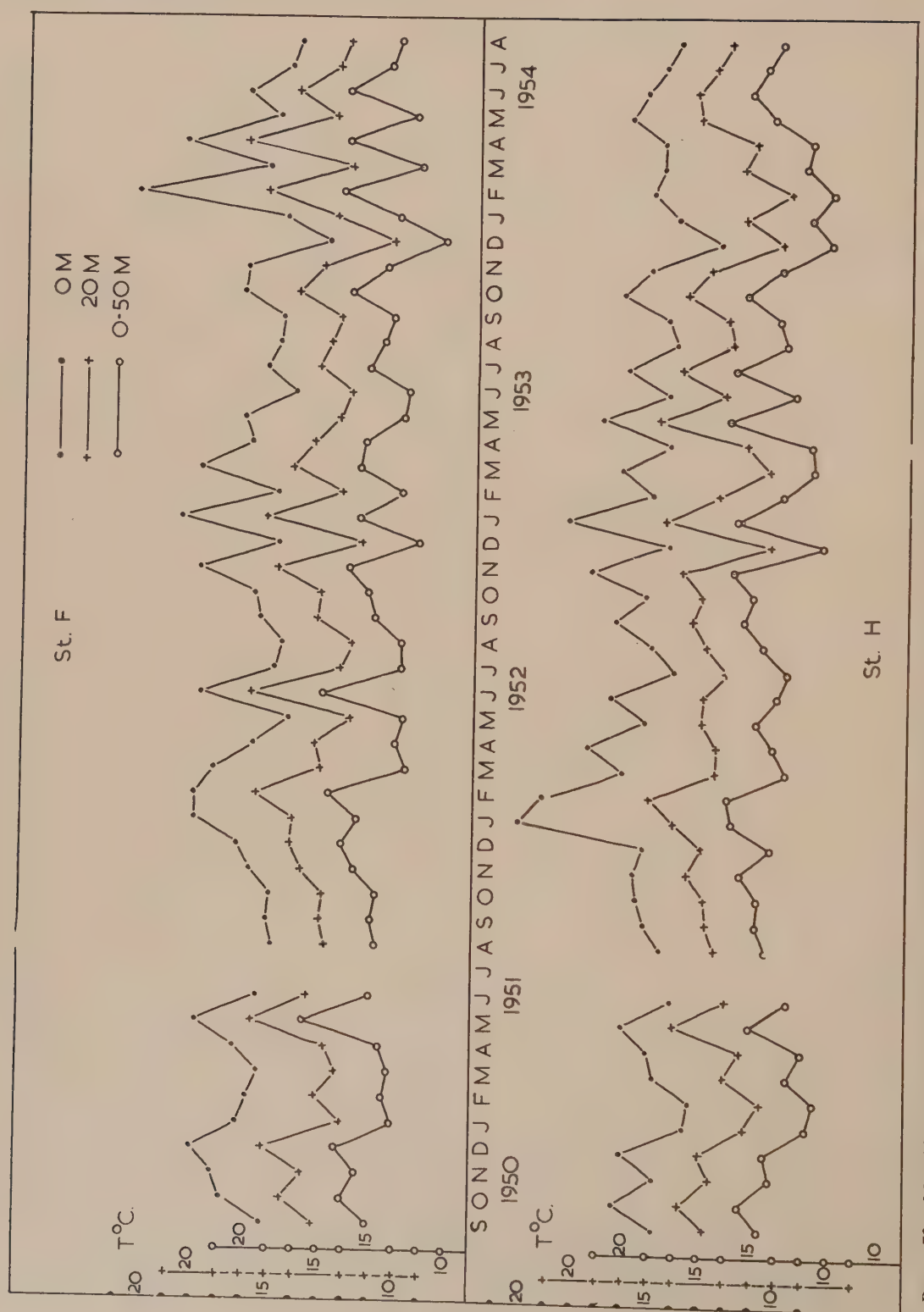

PLATE 73.—Monthly variation of surface, 20 metres and 0–50 metres mean integral temperatures at individual stations, September, 1950—August, 1954.

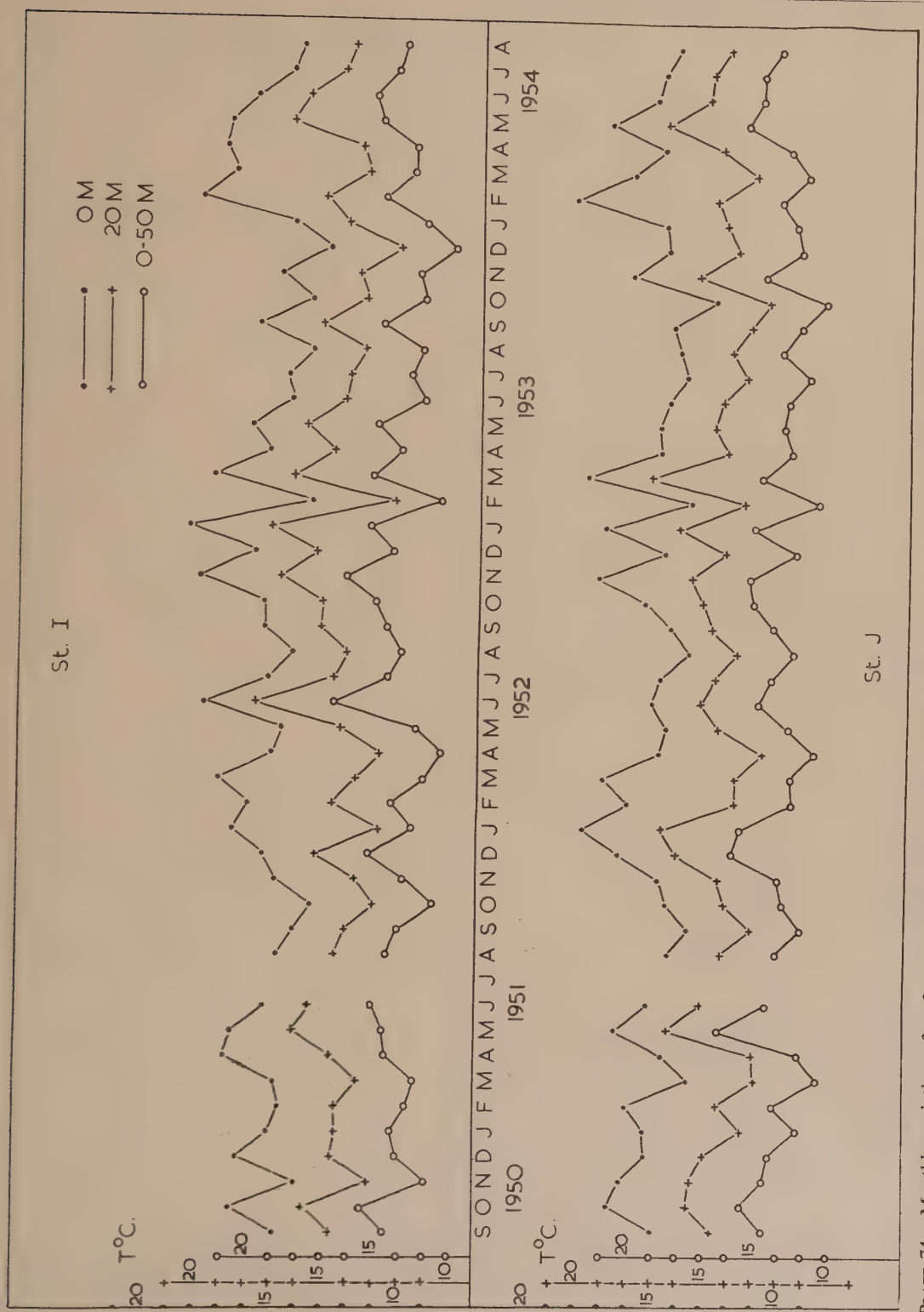

PLATE 74.—Monthly variation of surface, 20 metres and 0–50 metres mean integral temperatures at individual stations, September, 1950—August, 1954.

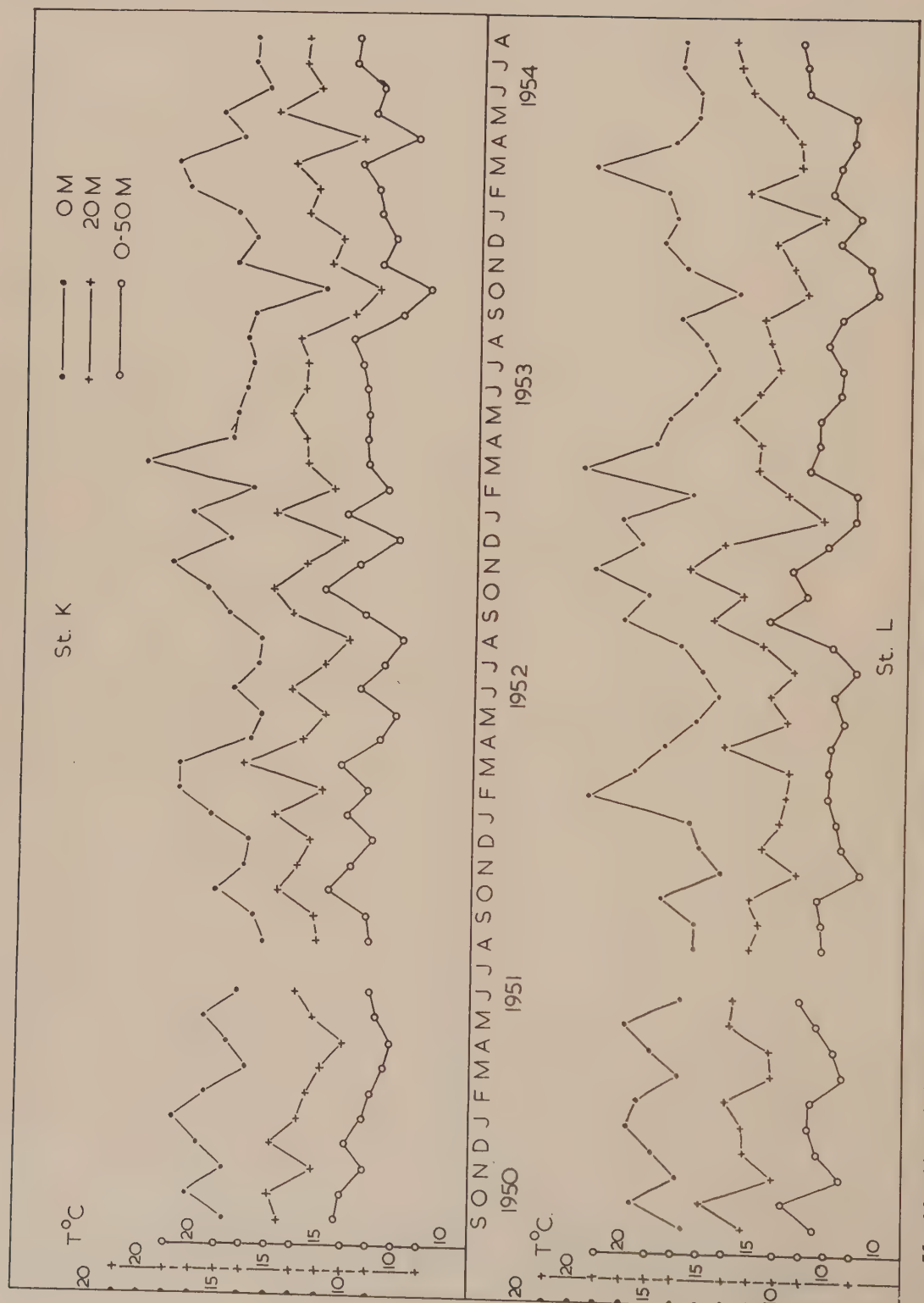

PLATE 75.—Monthly variation of surface, 20 metres and 0–50 metres mean integral temperatures at individual stations, September, 1950—August, 1954.

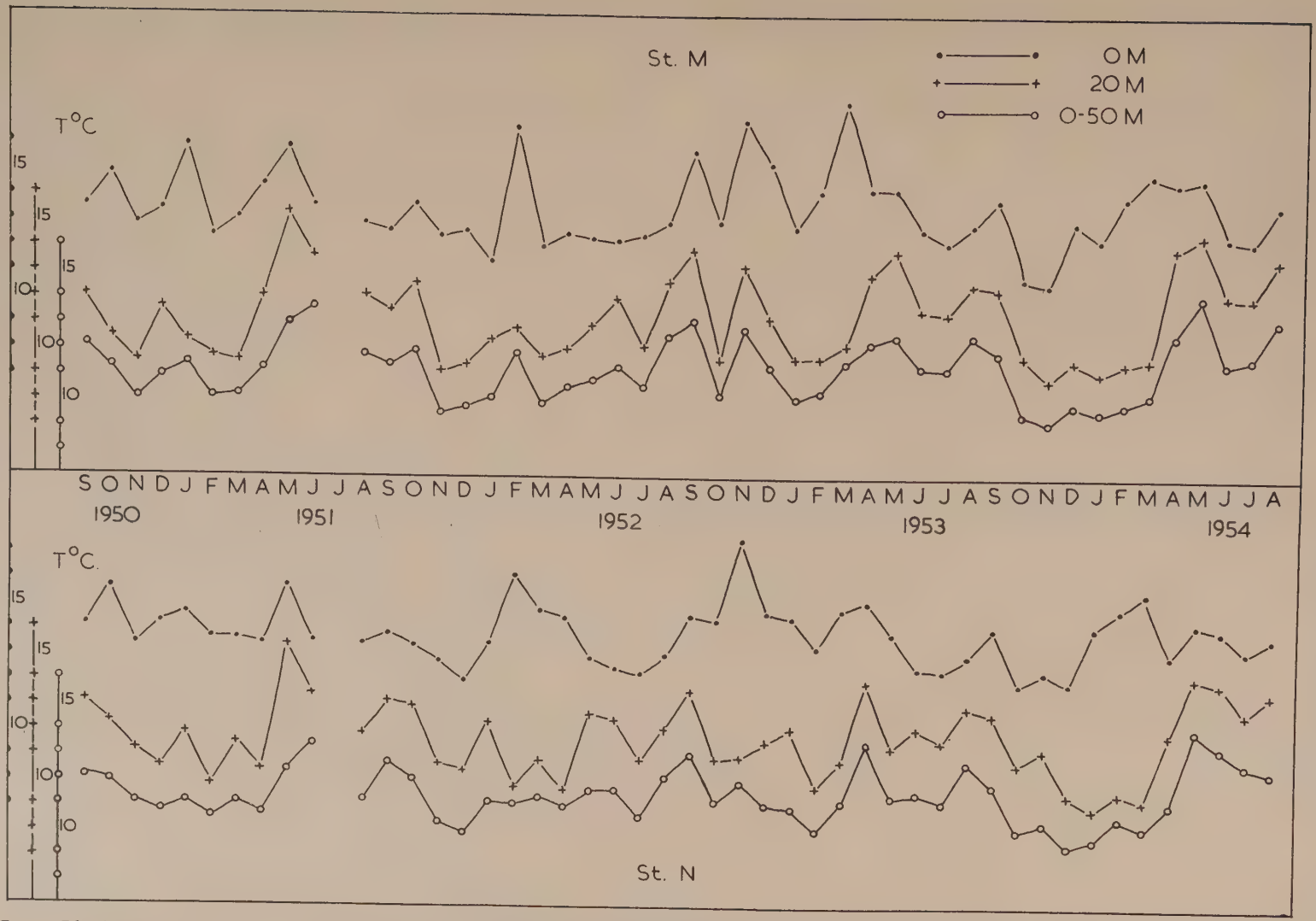

PLATE 76.—Monthly variation of surface, 20 metres and 0–50 metres mean integral temperatures at individual stations, September, 1950—August, 1954.

Reprint from "Commerce & Industry", August, 1957

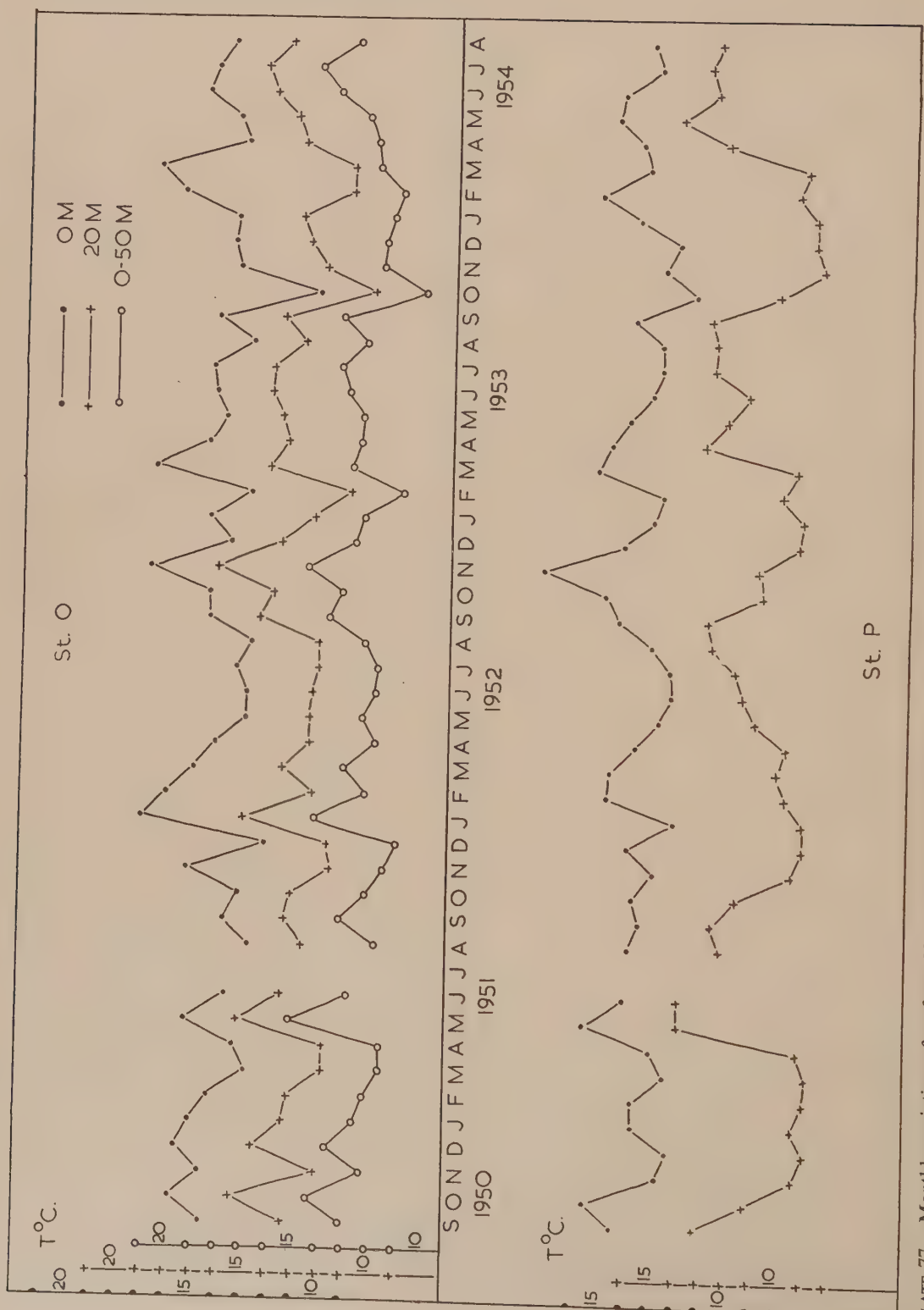

PLATE 77.—Monthly variation of surface, 20 metres and 0–50 metres mean integral temperatures at individual stations, September, 1950—August, 1954.

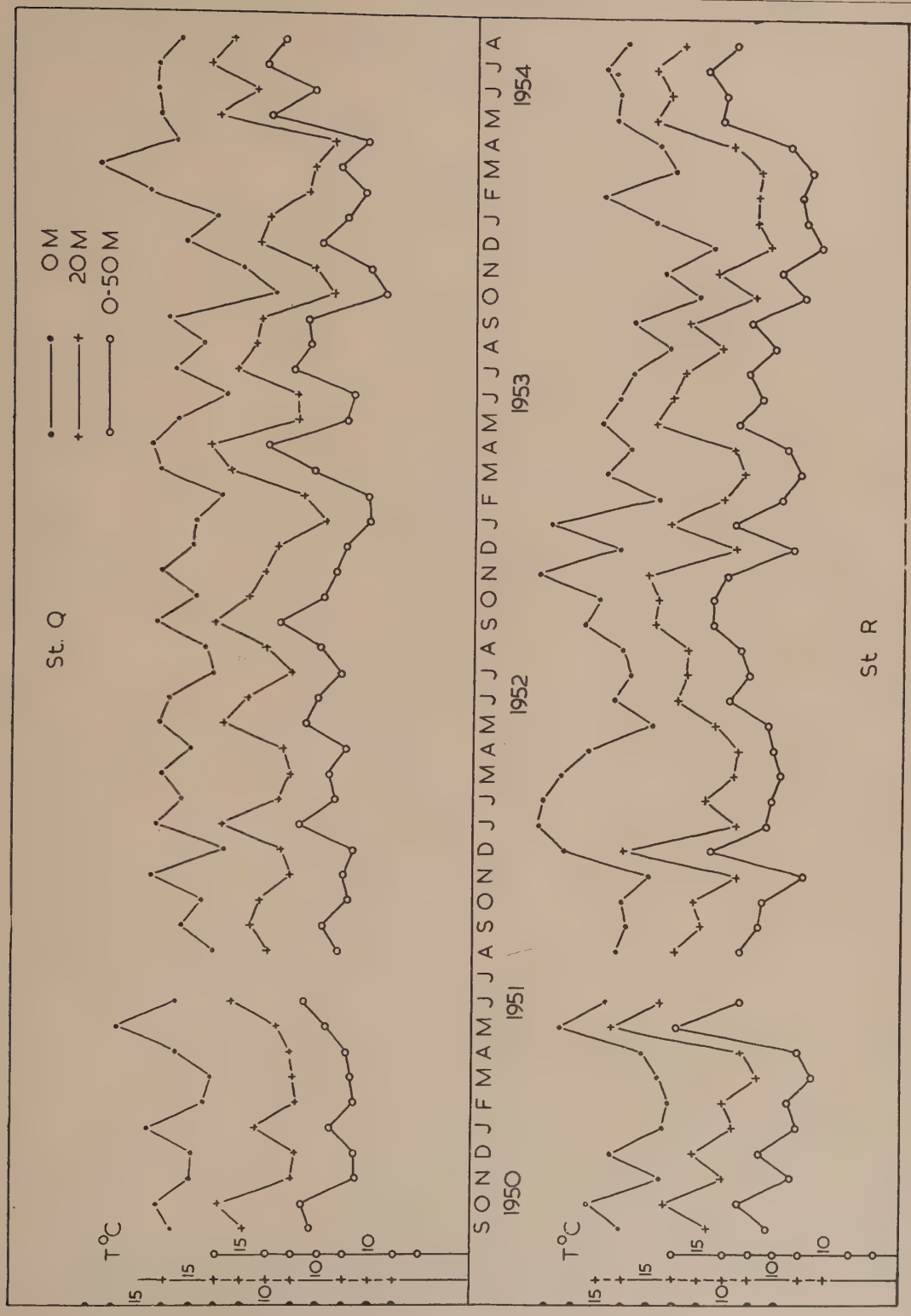

PLATE 78.—Monthly variation of surface, 20 metres and 0–50 metres mean integral temperatures at individual stations, September, 1950—August, 1954.

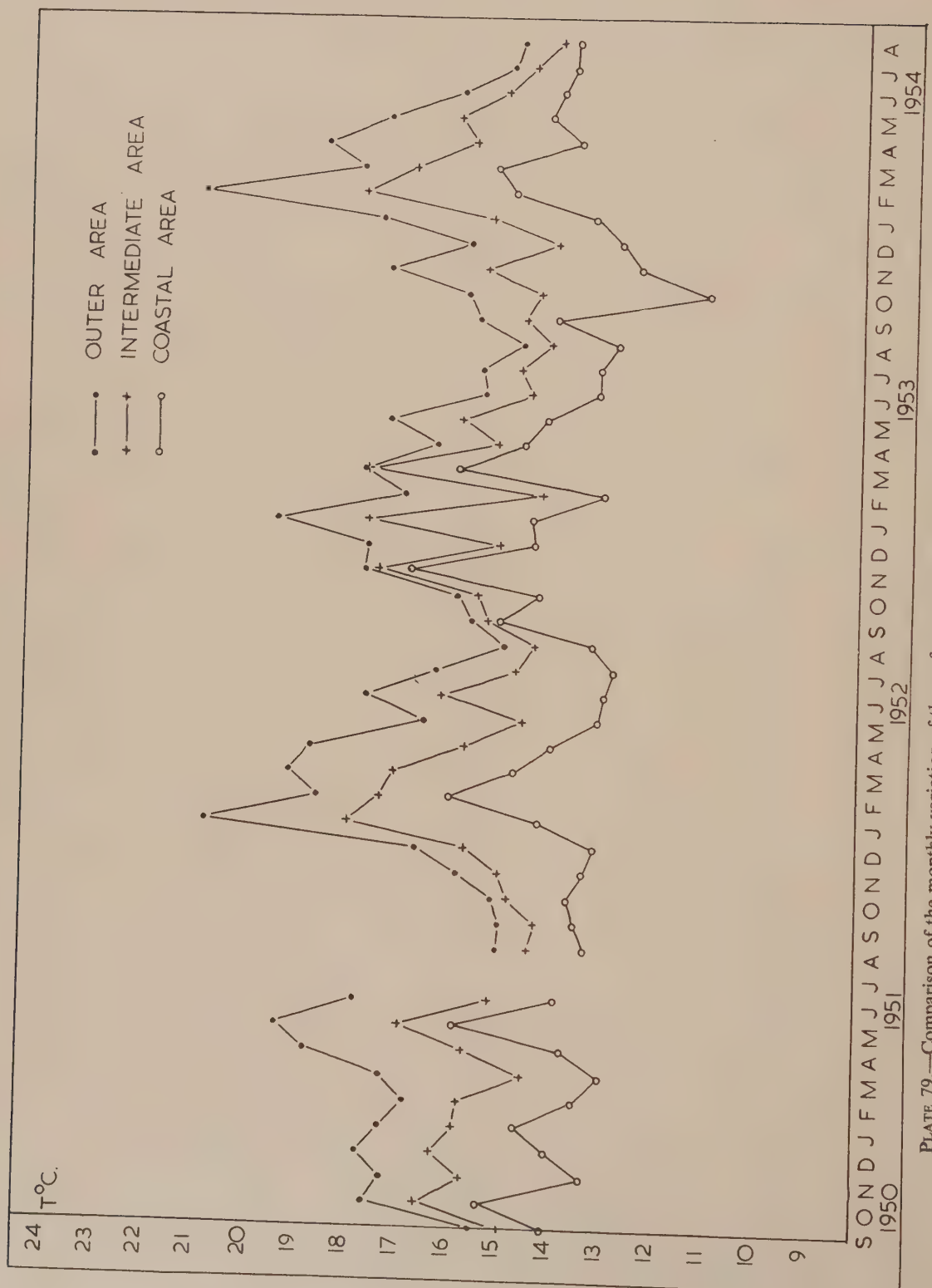

PLATE 79.—Comparison of the monthly variation of the surface temperature in the outer, intermediate and coastal areas.

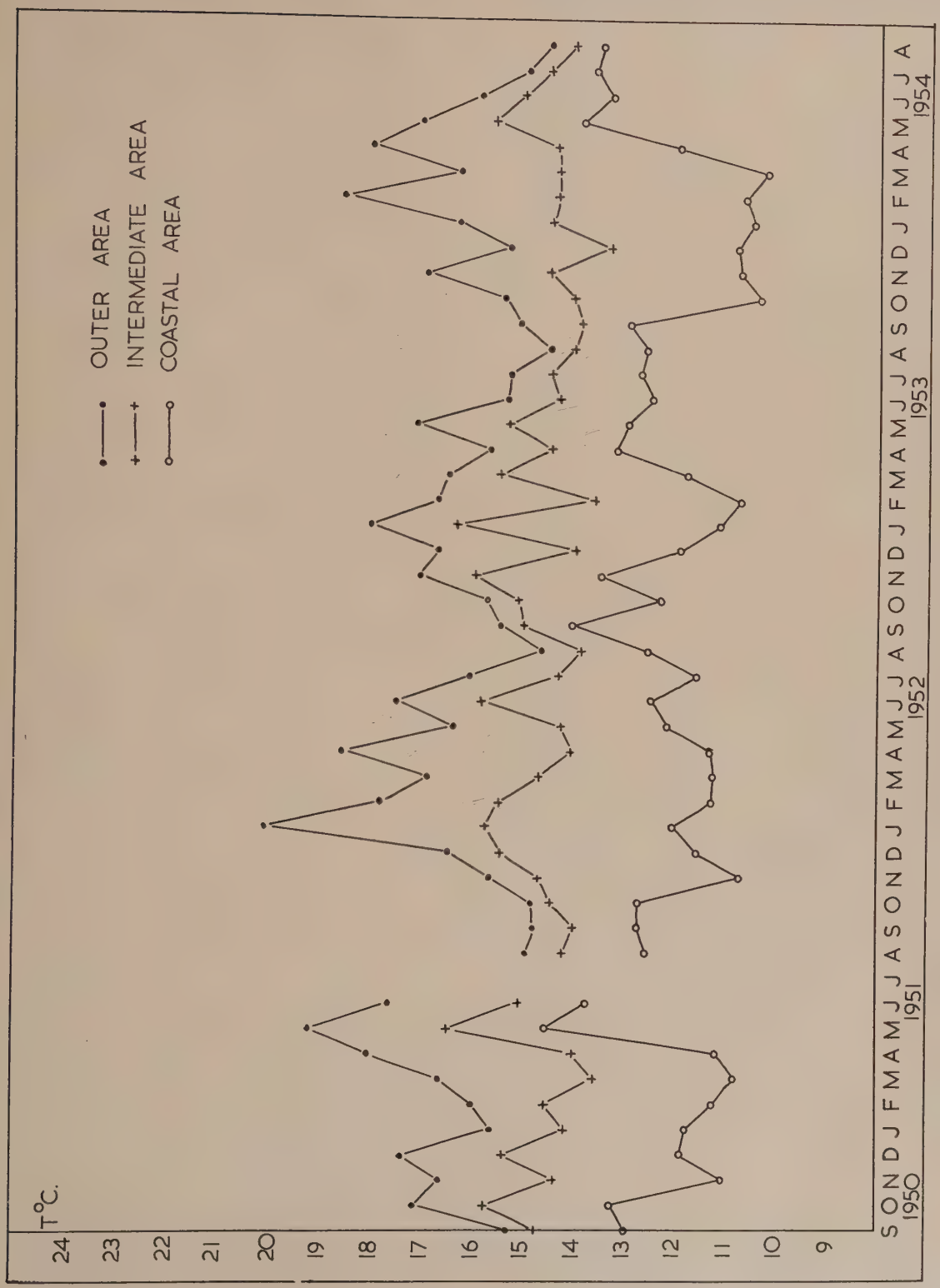

PLATE 80.—Comparison of the monthly variation of the 20 metres temperature in the outer, intermediate and coastal areas.

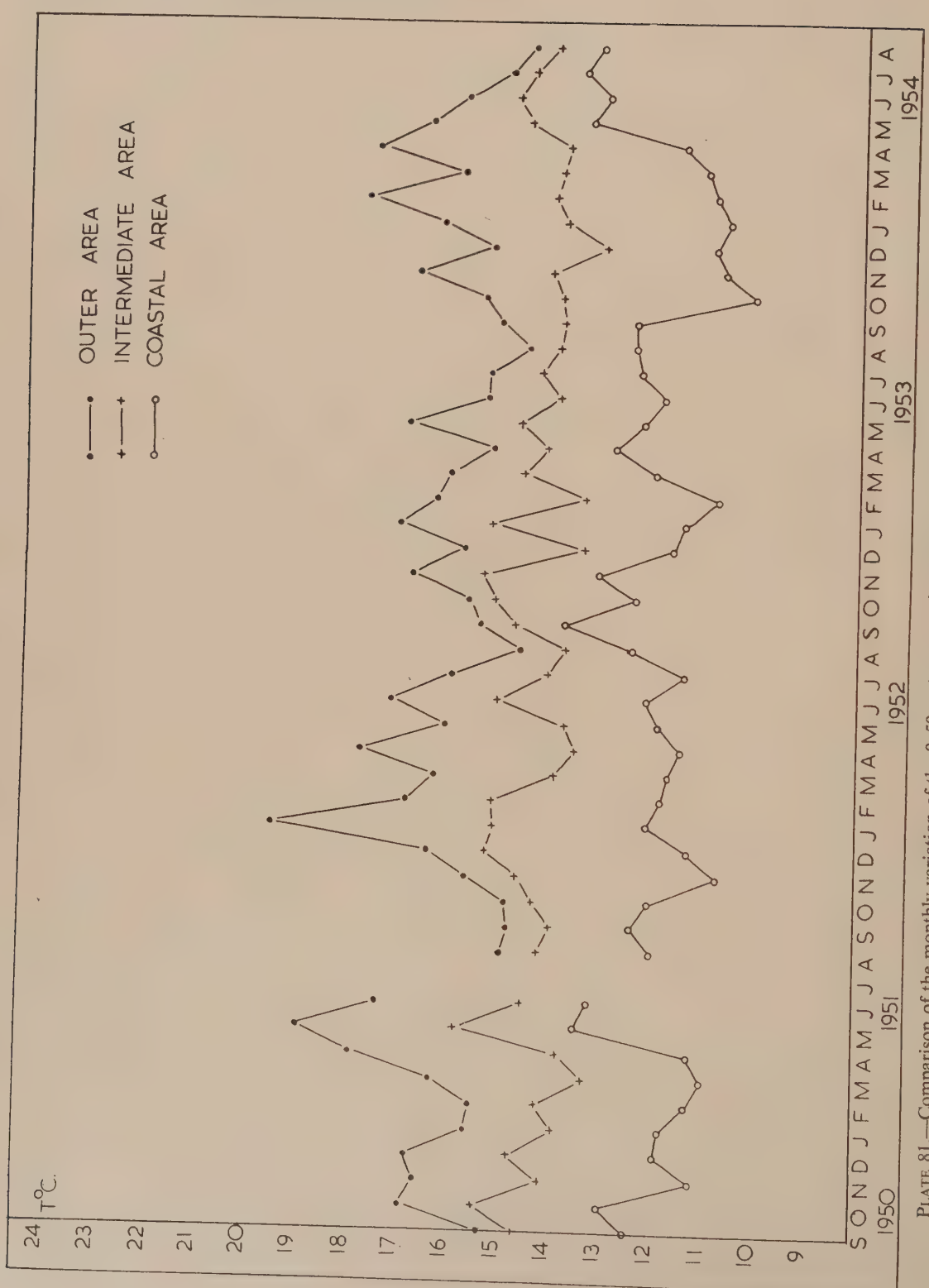

PLATE 81.—Comparison of the monthly variation of the 0–50 metres mean integral temperature in the outer, intermediate and coastal areas.